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THE CURRENTS OF LAKES MICHIGAN AND HURON

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INTRODUCTION

The information presented in this booklet is part of the results of a continuing program of research designed to provide various kinds of fundamental information that are needed in the solution of practical problems in the Great Lakes. Knowledge of the currents is one of these basic types of information. That currents directly affect navigation and recreational boating is obvious -- but that they also contribute to shore erosion, to silting-up of harbors, to the spreading of pollution, and to the distribution of fish-foods is not so evident though just as true.

This pamphlet has been prepared by the Great Lakes Research Institute at the request of the Great Lakes Cruising Club. It presents in non-technical language our present information about the surface currents of Lakes Michigan and Huron. The material given here is an abridgment of more detailed technical information contained in "Currents and Water Masses of Lake Huron" and "Currents and Water Masses of Lake Michigan," both being publications of the Great Lakes Research Institute of the University of Michigan.

No pretense is made that the surface currents shown here are the only ones possible, but there is a considerable body of evidence that the current patterns for prevailing-wind conditions (also called the "normal" currents) are representative of the usual currents in the two lakes. The current speeds obtainable from the current charts are average speeds. Local currents may vary from the speeds indicated on the charts by as much as tenfold, either faster or slower.

No effort is made to indicate possible uses of the material contained in this booklet. The author, the Great Lakes Research Institute, the University of Michigan, and the Great Lakes Cruising Club are not responsible for incidents arising out of the use or misuse of the information here presented.

Charts 1 and 2 give the common-place names referred to; they are included for the reader's convenience.

THE "NORMAL" CURRENTS

Lake Michigan

Charts 3 and 4 show the surface currents of Lake Michigan on 28 and 29 June 1955. On each of these days the lake was completely covered by the simultaneous cruises of eight vessels -- giving an overall picture of conditions in the whole lake on each day. Chart 19 shows the courses of the vessels and the sampling stations they visited.

Winds prior to these coverages had been from quarters more or less normal for that time of year. In the author's opinion, the wind conditions (and hence the currents) in the southern half of the lake were somewhat more typical on 29 June than on 28 June, while in the northern half the wind directions at Escanaba and Sault Ste. Marie were more nearly from the prevailing directions on 28 June than on the 29th. It is believed that the normal current pattern is most accurately represented if the currents of 29 June for the region south of latitude 44° (Ludington - Manitowoc) are combined with those of 28 June for the region north of 44°. The "normal" current pattern described later will be from this combination of days.

The southern half of the lake is sufficiently wide to exert a modifying effect on winds crossing it. Summer winds coming to the lower lake from southerly or westerly quarters are warm from their passage over the inland states. Upon moving out onto the lake, which is cooler than the air, the lower levels of the moving air are cooled by the lake and contract. The contraction of the lower air starts a descending motion in the moving air and barometric pressure over the lake will be somewhat higher than that over the land upwind. Cooling by the lake, setting up a descending motion in the moving air and causing over the lake a "high" of greater or less strength, should produce some tendency for winds to radiate around the "high" in a clockwise direction. The condition of clockwise effective wind directions around the southern half of the lake (arrows marked "W" in the charts) was somewhat better realized on 29 June 1955 than on the preceding day. The currents are driven by the wind but, because of the rotation of the earth, they move in a direction about 45° to the right of the wind direction (arrows marked "T" in the charts). The somewhat more typical arrangement of wind directions on 29 June argues that the current pattern of that day will be somewhat nearer the "normal" than will the one of the 28th. Table 1 gives the winds of the periods of the Lake Michigan surveys.

The southern half of Lake Michigan (in Chart 4) contains two dominant current features. A large flattened clockwise eddy commonly lies close to the Michigan shore and extends from off Grand Haven to Michigan City. Associated with this eddy are two smaller ones which are counterclockwise and which, in the lee of the shore from Little Sable Point to Benton Harbor and from Michigan City to Chicago, have currents contrary to the wind. The second major feature of the current pattern is the outflow current which rises from the Wisconsin shore at about Rawley Point, then flows southward (just off shore) to about the offing of Waukegan where it turns offshore and crosses to the central and east-central part of the lake; here it becomes associated with the west side of the large east-shore eddy and moves northward to come to the Michigan shore at Big Sable Point. Small clockwise eddies lying off Waukegan, off Kenosha, and off Milwaukee are associated with the outflow

current and are run by it as a large gear would run three small gears.

Currents in the west-central part of the southern half of the lake appear to be weak, except from Michigan City northward to the offing of Waukegan.

In the northern half of the lake (in Chart 3) the dominant feature is the outflow current which passes up the Michigan shore from Big Sable Point past Point Betsie and the Manitou Islands almost to Seul Choix Point on Michigan's Upper Peninsula. Off Seul Choix Point the current divides, with the larger portion making a U-shaped swing southward to pass below Beaver Island and approach the Straits of Mackinac from the southwest, and the smaller portion passing eastward above the Beaver Islands to the straits. The outflow current runs small clockwise eddies in the embayments between Big Sable Point and Point Betsie, between Point Betsie and Sleeping Bear Point, in Little Traverse Bay, and in Sturgeon Bay (Michigan). It also drives counterclockwise eddies situated off Naubinway, Port Inland, and Manistique on the Upper Peninsula of Michigan.

On the west side of the northern part of the lake the currents tend to be southward with the outflow from Green Bay contributing part of the alongshore flow. A large counterclockwise eddy lies in the east-central part of the lake off Frankfort.

The Straits of Mackinac

Under prevailing winds the surface current in the Straits is to the east with division of the flow after it has passed Point Mackinaw. The major part of the current passes down South Channel, for prevailing winds are from the north of west. Minor portions of the current pass between Mackinac Island and Round Island; current speeds in this pass may be high as a result of the narrowness of the channel. Prevailing winds usually cause southward current between Mackinac Island and St. Ignace.

Lake Huron

Chart 5 shows the surface current pattern of Lake Huron on 29 June 1954. Three multiple-vessel single-day coverages of the lake were made during the summer of 1954; of the three the one shown is the most "normal." Chart 20 shows the courses of the vessels and the stations they visited. Winds prior to this coverage (Table 2) were more consistently from the prevailing directions than was true in the days before the other two. Further, the results shown in Chart 5 are confirmed by two previous all-shipping-season-long studies of currents which gave the same main current features but did not cover the lake so completely.

There are two primary features in the Lake Huron current pattern: the flow-through current and the mid-lake eddy. The flow-through current is the belt of main current by which the inflows from Lakes Michigan and Superior pass along the length of the lake and arrive at the St. Clair River. The mid-lake eddy is a large counterclockwise eddy of current located in about mid-lake between Presque Isle and Cape Hurd. As was the case in Lake Michigan, smaller eddies are associated with, and driven by, both the primary current features.

The flow-through current originates in the eastern part of the Straits of Mackinac. Lake Superior water emerging into Lake Huron through Mississagi

Strait, False Detour Channel, and Detour Channel flows westward along the north shore to about Les Cheneaux Islands. Here it meets the outflow from Lake Michigan and the two unite and turn southeast. The region of junction of the two waters is east of Mackinac Island and about north of the east end of Bois Blanc Island. The united flows move southeastward along the shore of Michigan's Lower Peninsula to Presque Isle. Just beyond Presque Isle the current leaves shore by continuing to the southeast while the shore trends southward. From Presque Isle to mid-lake at latitude 44° 30' the outflow current is about 15 miles in total width with the strongest currents in the center seven or eight miles.

In the offing of Thunder Bay the current begins to fan out gradually and the fanning out continues to mid-lake at 44° 30' where the current separates into two branches. One branch (the smaller one) turns eastward for a few miles and then curves into a northward direction and enters the mid-lake eddy. The major portion (the flow-through current) is contained in the branch that moves west and reaches the Michigan shore throughout the region from Sturgeon Point to Oscoda.

Flowing southward after reaching the Michigan shore, the flow-through current in part dips into the outer end of Saginaw Bay as far as Big Charity Island and in part crosses directly across the mouth of the bay. At Pointe aux Barques the current is again narrow and close to shore. From Pointe aux Barques the flow-through current moves northeast to the center of the lake, then turns south for about 35 miles. In mid-lake off Harbor Beach the current curves to the southwest and returns to the Michigan shore. It runs along shore to Lexington where it turns southeast and moves to the center of the lake and then curves southwestward. It reaches the St. Clair River as strong flow from the northeast in the eastern half of the extreme lower end of the lake.

Associated with the flow-through current, and driven gear-wise by it, are five medium-to-small eddies of current. A clockwise eddy outside Thunder Bay and a small counterclockwise one in Thunder Bay are the first two of the five. Off the mouth of Saginaw Bay a medium-sized eddy is formed by the westward meander of the flow-through current. On the Ontario shore off Goderich is a counterclockwise eddy driven by the flow-through current. The final eddy of the five is a small clockwise eddy situated off Lakeport, Michigan.

Returning to mid-lake at 44° 30' and the eastward branch of current, we find that this branch is the chief contributor to the mid-lake eddy. From 44° 30' this branch flows successively east, north, northwest, and southwest to rejoin the eastern side of the flow-through current in the offing of Presque Isle and thus to circumscribe the mid-lake eddy.

A long flattened clockwise eddy driven by the mid-lake eddy is located along the Ontario shore from Cape Hurd to Clark Point. At the entrance to Georgian Bay, waters from this eddy and from the mid-lake eddy pass eastward into the bay. There is some evidence that average surface current in Owen Channel between Fitzwilliam Island and Manitoulin Island may be westward, but the evidence is not very conclusive and this current is not shown on the chart.

On 29 June 1954 the east side of the mid-lake eddy showed a reversed-S of current between latitudes 45° 00' and 45° 30'. It is doubted that this is a permanent feature of the eddy. Until this is proven, the east side of the eddy should be considered as being approximately parallel to the trend of the Canadian shore.

Along the shores of Manitoulin, Cockburn, and Drummond Islands there are currents of some strength moving westward parallel to shore. The waters

involved in this flow appear to come mostly from the mid-lake eddy, with minor additions received from Mississagi Strait, False Detour Channel, and Detour Channel.

Detailed studies in Saginaw Bay were carried out by the United States Fish and Wildlife Service in 1955. They confirmed the counterclockwise trend of currents which Chart 5 indicates as "estimated" in the inner end of the bay. The author greatly appreciates their permission to use this information.

Drift Bottle Studies

The drift of floating objects has provided man with both food for thought and information about currents since he first approached a sea-faring mode of life. Tropical woods stranded as driftwood on the coast of Ireland are cited among the several reasons that Columbus believed the "Indies" lay west of Europe. Few persons will pass an empty bottle on the beach without at least a stolen glance to see if it contains a "bottle note." Interest in the paths taken by flotsam stems from several causes. It may have a sanitation basis (as when a public health official suspects that the sewer outfall is upcurrent from the water intake), a more macabre undertone (the location or back-tracking of a drowned body), or any of several other causes, but generally it is nothing more than plain human curiosity.

For many years use has been made of the beachcomber's natural "wonder where it came from?" to obtain information about currents. Bottle messages released at sea are accompanied by a return postcard upon which the finder is asked to report the date and place of discovery. The whole package of message, return card, and bottle is commonly called a "drift bottle."

Charts 6 and 7 and Tables 3 and 4 show the release points and discovery points of 161 drift bottles released in Lake Michigan on 28 and 29 June 1955. Chart 19 shows the stations where the bottles were released. It is of course impossible to tell the actual path travelled by a drift bottle, but the direction of its movement is convincing evidence of the direction of the current. Since a drift bottle usually remains afloat for several days, its average rate of travel is an average of its movements in fast currents and in slow ones. The average current speeds obtainable from Charts 3, 4, and 5 have been derived from a complicated computation of the distribution of density of the water, but they have been checked by (and are in good agreement with) the average speeds of the drift bottles that travelled in the same regions.

When several drift bottles are released at one place, the straight lines connecting release point to place of recovery may all run nearly side-by-side (indicative of strong currents) or they may fan out (indicating the successive stranding of bottles moving in a circular path). The paths of bottles released off Manistee in Chart 6 and just off Charlevoix in Chart 7 are good examples of the strong-current type of distribution; the movements of those released off Manistique in both charts show the fan-shaped distribution indicative of stranding from an eddy.

Chart 8 and Table 5 give the release points and recovery points of 89 drift bottles from releases made in Lake Huron on 29 June 1954. Chart 20 shows the stations where releases were made. Strong-current distributions of the bottles are indicated in South Channel of the Straits of Mackinac, False Detour Channel, and at the extreme end of the lake near the mouth of the St. Clair River. Fan-shaped distributions indicative of bottles stranding out of eddies are shown off Goderich and along the Saugeen Peninsula.

One bottle of the Lake Huron releases obviously had human help in its travel, for it "moved" from the middle of the south shore of Manitoulin Island to Oliphant, Ontario in 12 days. That it moved almost directly opposite to releases at nearby points, that it would have had to make more than half the straight-line trip against the currents, or that it would have had to travel at anomalously high speed to have made the trip around the mid-lake eddy in 12 days were points the prankish and not-too-honest finder failed to appreciate.

WATER TEMPERATURES

Chart 9 gives the distribution of surface water temperatures on 29 June 1955, one of the days of "normal" current pattern in Lake Michigan. Chart 10 shows a similar "normal" surface temperature distribution on 29 June 1954 in Lake Huron. In each of these charts the positions of each whole degree of Centigrade temperature have been connected by lines. Each of these lines or isotherms should be considered as delimiting a "puddle" or band of water which was colder on one side of the line and warmer on the other. A "V" lying on its side with the point to the right means "more than"; one with its point to the left means "less than" and should be read with the number closest to it.

Because Centigrade temperature values are not in general use in this country, the following table of equivalent temperatures is included:

0^{o} C or 32.0^{o} Fahrenheit (freezing)		15^{o} C or 59.0 F	
6^{o} C or 42.8 F		16^{o} C or 60.8 F	
7^{o} C or 44.6 F		17^{o} C or 62.6 F	
8^{o} C or 46.4 F		18^{o} C or 64.4 F	
9^{o} C or 48.2 F		19^{o} C or 66.2 F	
10^{o} C or 50.0 F		20^{o} C or 68.0 F	
11^{o} C or 51.8 F		21^{o} C or 69.8 F	
12^{o} C or 53.6 F		22^{o} C or 71.6 F	(room temperature)
13^{o} C or 55.4 F		23^{o} C or 73.4 F	
14^{o} C or 57.2 F		24^{o} C or 75.2 F	

The charted temperatures are for late June; they increase slowly during the summer and by late August may be as much as 4^{o} C higher in the shallower portions of the lakes. The very cold spot in the center of Lake Huron is a special case, it warms to about 16^{o} C or 60.8^{o} F by late August when surface warming cuts off a rising of cold subsurface water there.

Dashed lines on the temperature charts indicate that there is some uncertainty as to where the lines should go.

Since temperature is the primary (but not the only) factor in determining the density of fresh water and since the distribution of density has been used in computing the probable current pattern, the reader might be interested in seeing the temperature distributions. Rough estimates of current direction can be made from the fact that the warmer water is on the observer's right when he faces in the direction that the current is going.

THE UNUSUAL CURRENTS

Lake Michigan

On 9 and 10 August 1955 multiple-boat single-day coverages of Lake Michigan were carried out. Winds at Chicago and Milwaukee were from easterly quarters on the 7th, 8th, and 9th; at Grand Rapids and Sault Ste. Marie they were from easterly quarters on the 8th and 9th; Escanaba had north winds on the 7th and south winds on the 8th and 9th; on the 10th the winds at all these stations were from westerly quarters, except at Chicago which had east winds. In other words, the surveys on the 9th and 10th came after winds which were from unusual quarters. The current patterns in the lake on these two days may be taken as representing the currents to be expected during the second day of a two-day easterly blow. Table 1 gives the winds that preceded all four of the Lake Michigan surveys.

Currents in the lake do not respond immediately to wind changes, in fact the evidence indicates that the currents present on any given day reflect the wind directions plus rotation of the earth ("T" arrows around Lake Michigan charts) of the days prior to the one in question, but not of the day in question. If you are sailing today, you are encountering the currents set up by the winds of yesterday, the day before, the day before that, etc., but the effects of today's winds will not be showing until tomorrow. The effectiveness of previous winds in today's current pattern falls rapidly as the days become farther in the past. Yesterday's winds would be ranked, for example, as 1; those of the day before as 1/2; those of the day before that as 1/4, etc. For practical purposes the winds of the preceding four or five days are usually all that need be considered, but to be strictly accurate about ten days need to pass before the effects of a day's winds are completely gone from the current pattern. The "W" arrows on the Lake Michigan charts are the effective wind direction of the preceding ten days.

Today's winds spend their energies changing the current pattern left by yesterday; the changed pattern will be operative tomorrow at the soonest. If today's winds are from the same direction as yesterday's, their effects will show in increased current speeds tomorrow. If today's winds are opposite to those of yesterday, they will show as slowed currents, stopped currents, or reversed currents tomorrow according to whether today's winds are weaker, equal to, or stronger than yesterday's. Wind shifts amounting to less than actual reversal of direction will cause changes in both the directions and speeds of the currents, as a moving billiard ball when struck by the cue ball takes up a new direction and a new speed that combine those it originally had with those it received from the cue ball.

Chart 11 gives the currents in Lake Michigan on the second day of an easterly blow (third day at Chicago). The dominant feature in the current pattern on this day, 9 August, was a strong and wide southward current along the east shore from the Straits to Chicago. The large eddy found against the Michigan shore under "normal" winds was displaced to the center of the lake. The outflow current also was crowded away from the Michigan shore. It ran almost up the middle of the lake as far as the offing of Frankfort where it crossed to the mouth of Green Bay and then went eastward along the shore of the Upper Peninsula of Michigan. In the western part of the Straits of Mackinac the outflow current was denied escape into Lake Huron by the water transport direction ("T" arrow) accompanying the winds in the Straits.

The water transport direction in the Straits appears to be the key to the whole current pattern in Lake Michigan. When the effective wind direction (resulting from the preceding few days' winds) is from too far north or east the accompanying water transport direction is headed back into Lake Michigan and surface outflow to Lake Huron is stopped. At such times the outflow current turns down the east shore of the lake and reinforces the southward current which is being formed by the T-arrow water transport forces. At such times, also, Lake Huron water is pushed into Lake Michigan through the Straits. The levels of the two lakes are kept in balance at such times by a subsurface flow of water from Lake Michigan into Lake Huron.

In Chart 11, on the second day of the easterly blow and before the full effects of the blow had developed, northeast effective winds with westward water transport were pushing the currents away from shore in the Grand Rapids area. In the Chicago region they were drawing the east-shore south current over to the city. At Milwaukee they were moving water toward shore but its effect would not be fully expressed until the next day. At Escanaba the water transport direction was such as to draw water in through the mouth of Green Bay (and probably produce strong eastward current in Sturgeon Bay Canal).

In Chart 12, after two full days of easterly winds (three at Chicago) the east-shore south current was wide and extended out to the center of the lake. The large clockwise eddy normally against the Michigan shore in the southern part of the lake had been pushed over against the Illinois shore in the region between Wilmette and the Wisconsin boundary. At Milwaukee, water had been transported onto shore until it made a wind set-up, or hill of water, and on the slope of this set-up current ran south as it should under such conditions. The outflow current was broken at latitude 43° 45'. The southern part flowed eastward below Milwaukee to join the east-shore south current; the remainder formed a large and flattened eddy off the mouth of Green Bay. Except for Grand Traverse Bay and the eddy off Naubinway, the eddies in the northern half of the lake were reversed in current direction from their normal condition.

Lake Huron, Winds North of Normal

In Chart 13 is shown the current pattern of Lake Huron on 27 July 1954. This survey followed winds (Table 2) which, in the Straits region, were from the "normal" west northwest direction during the days before the survey. Consequently, the currents in the upper end of the lake were essentially as in the normal pattern given in Chart 5. A small eddy in South Channel was the only well-substantiated difference. A scanty amount of evidence suggested that there might have been eastward current along the shores of Drummond, Cockburn, and Manitoulin Islands, but there was little certainty of it.

In the central part of the lake the winds during the week prior to 27 July had been from the north for three consecutive days (Table 2) and the currents appeared to be recovering from the southwestward distortion that such winds would have imposed upon them. The recovery was not being materially helped by northwest winds just before the survey. North winds blow south but the rotation of the earth converts the wind energy into a water-moving (water transport) force about 45° to the right of the wind movement, i. e., a north wind tends to move water to the southwest. In the same fashion northwest winds blow southeast but move water south.

The flow-through current off Thunder Bay was just off the Michigan shore, but still made a westward turn to come shoreward in the region from Sturgeon

Point to Oscoda. It still travelled south along the shore past Tawas Point and dipped into Saginaw Bay. The eddy that normally lay off the mouth of the bay was almost against shore at Oscoda. The flow-through current emerged from Saginaw Bay along the south shore of the bay mouth, but instead of going northeastward to mid-lake it passed in a southeasterly direction almost to the Ontario shore from whence it moved southwest to the St. Clair River.

The mid-lake eddy was almost non-existent on 27 July. All that remained of it was a circular arrangement of weak currents off Macpherson Point. A weak eastward branch of the flow-through current left that current at about 44° 10' and passed northeastward along the side of the remnant of the mid-lake eddy. Another eastward branch of the flow-through current left the east side of that current in latitude 44° 45' and crossed almost to the Saugeen Peninsula. This is interpreted as being the beginning of the re-establishment of a normal mid-lake eddy as the result of the west and northwest winds of the days just prior to the survey.

In the southern end of the lake the winds (Table 2) had been from the north and northeast for six days prior to the survey of 27 July. The southward and westward displacement (of currents) resulting from these winds causing the flow-through current to slant southeastward across the lake instead of going northeast to mid-lake then south and southwest to reach the Michigan shore below Harbor Beach. The counterclockwise eddy which "normally" was situated off Goderich was, on the 27th, at Grand Bend.

Lake Huron, Winds South of Normal

On 25 August 1954 Lake Huron was surveyed after the winds over the central and southern parts of the lake had been from the south and east for four of the preceding seven days (Table 2). Chart 14 presents the current pattern in the lake on 25 August. Again, winds in the Straits region were from essentially the normal west northwest, and again the currents in the upper portion of the lake were not materially modified from the normal condition.

In the central portion of the lake the currents were displaced to the east and north. The flow-through current was deflected to the eastward at Presque Isle and flowed eastward and northeastward to Manitoulin Island. In doing so, it passed around the south end of the mid-lake eddy which was displaced northward and was centered about at the Duck Islands.

Currents directed off the shore arose along the Michigan coast from Oscoda to Thunder Bay. About half of these turned eastward above Thunder Bay and crossed to Cape Hurd, from there they went northwest along the shore of Manitoulin Island and up the east side of the mid-lake eddy. The other half turned eastward above Thunder Bay but then went south almost to Pointe aux Barques. Here they curved northeastward and crossed into the east-central part of the lake off Macpherson Point. From there a part went northeast along the Saugeen (Bruce) Peninsula and a part flowed south along the center of the lake. The clockwise eddy normally situated at the mouth of Saginaw Bay was displaced to the north and east and lay about a third of the way across the lake. Inflow into Saginaw Bay appeared to be up the center of the bay mouth and outflow from the bay was along its south shore.

In the southern end of the lake, northeast currents rose from the shore between Lexington and Harbor Beach. These in part turned south in mid-lake east of Pointe aux Barques and in part joined the cross-lake current from Saginaw Bay and went to the offing of Macpherson Point before returning south

down the center of the lake and approaching the St. Clair River from the northeast. The small clockwise eddy normally off Lakeport was pushed up to the offing of Lexington.

Drift Bottle Studies

Charts 15 and 16 and Tables 6 and 7 give the release and discovery data on 78 drift bottles recovered from releases in Lake Michigan on 9 and 10 August 1955. These releases accompanied the unusual current condition in the lake and the movements of the bottles as well as their average speeds have been used as checks on the current directions and speeds of Charts 11 and 12 which were deduced primarily from the distribution of water density.

These drift bottles have been studied and used in the same way as were those accompanying the normal currents. No additional comment is considered necessary for the bottles of 9 August. The bottles released on 10 August fall into two groups, on the basis of their movements. Those recovered in less than four days (see Table 7) moved in directions that indicate they were carried by the unusual current condition present on 10 August. Those found and reported after four days or more moved in directions not like those of the unusual current pattern, but like those of the normal current pattern. They are believed to have stayed adrift until after the unusual currents had ceased and the winds and currents had returned to normal or nearly so.

Charts 17 and 18, and Tables 8 and 9, give the drift bottle data for the unusual current conditions in Lake Huron.

IN CLOSING

Abridgment such as has been made here is never completely successful. The omissions and condensations that are necessary always result in the loss of explanatory material, and sometimes result in ambiguities where the reader obtains an idea quite different from that being presented. The author honestly believes that he has been successful in avoiding ambiguities, but he also has a healthy pessimism about the matter. The material presented here has been abstracted from the surface temperature, drift bottle, and composite surface currents sections of the two full-fledged works indicated earlier. The perplexed reader is referred to them, they are not as difficult as they may look.

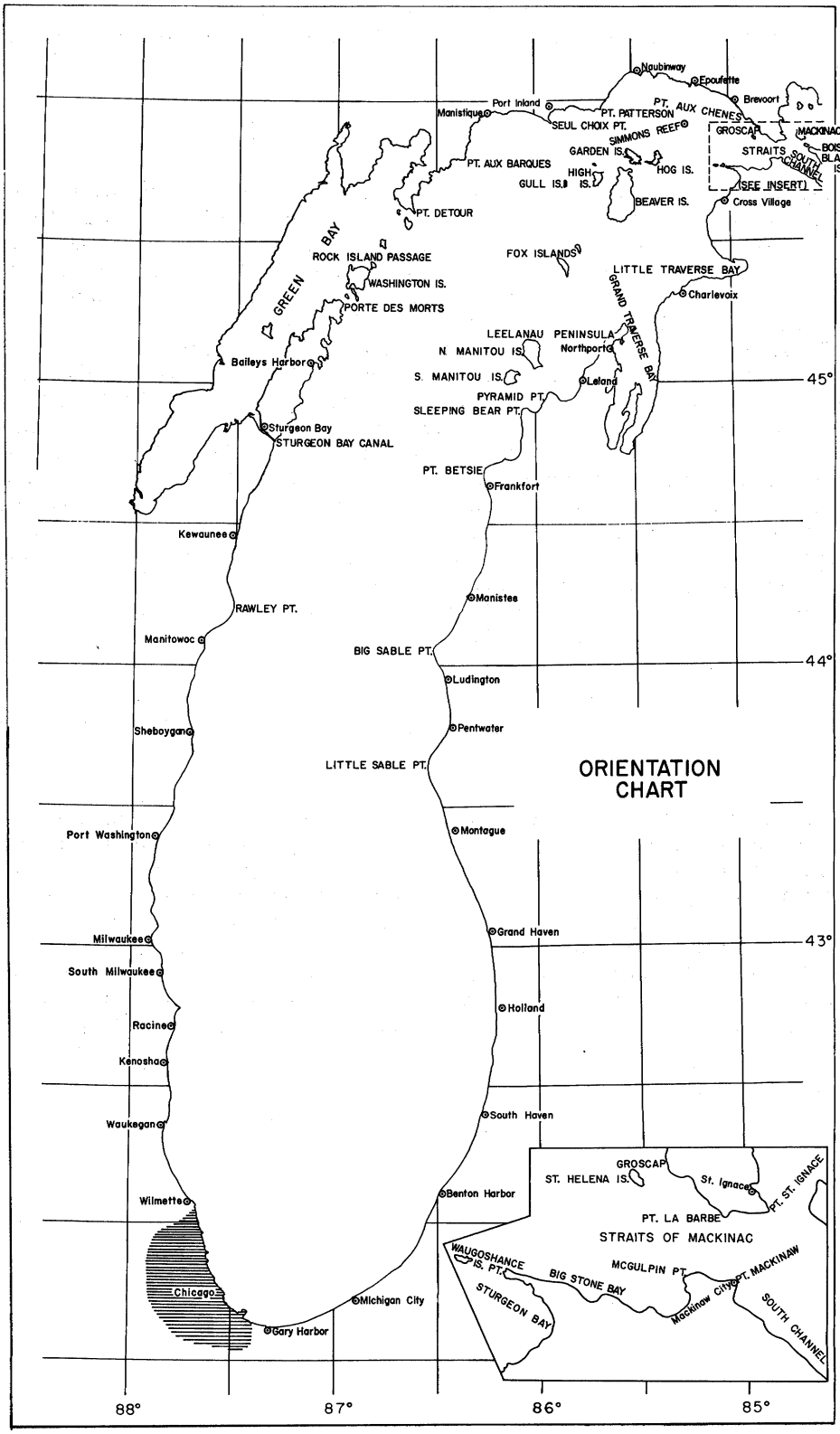
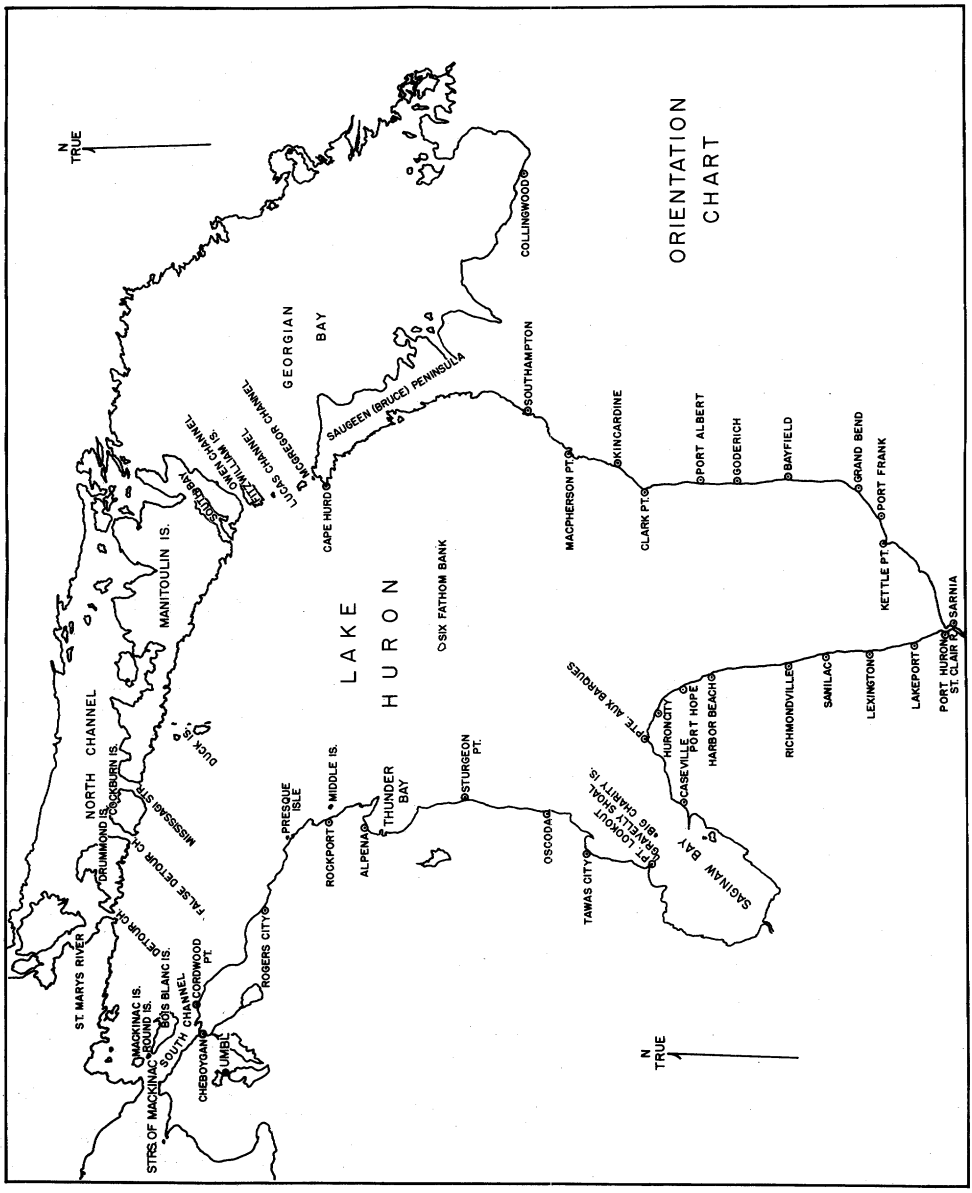

Naubinway
Epoufette
Brevoort
Port Inland
Manistique
PT. PATTERSON
PT. AUX CHENES
SEUL CHOIX PT.
SIMMONS REEF
GROSCAP
MACKINAC IS.
BOIS BLANC IS.
STRAITS
SOUTH CHANNEL
GARDEN IS.
HOG IS.
PT. AUX BARQUES
HIGH IS.
GULL IS.
(SEE INSERT)
BEAVER IS.
Cross Village
PT. DETOUR
GREEN BAY
ROCK ISLAND PASSAGE
FOX ISLANDS
LITTLE TRAVERSE BAY
WASHINGTON IS.
PORTE DES MORTS
Charlevoix
GRAND TRAVERSE BAY
LEELANAU PENINSULA
N. MANITOU IS.
Northport
Baileys Harbor
S. MANITOU IS.
Leland
45°
PYRAMID PT.
SLEEPING BEAR PT.
Sturgeon Bay
STURGEON BAY CANAL
PT. BETSIE
Frankfort
Kewaunee
Manistee
RAWLEY PT.
Manitowoc
BIG SABLE PT.
44°
Ludington
Pentwater
Sheboygan
LITTLE SABLE PT.
ORIENTATION CHART
Montague
Port Washington
Grand Haven
Milwaukee
43°
South Milwaukee
Holland
Racine
Kenosha
South Haven
Waukegan
GROSCAP
ST. HELENA IS.
St. Ignace
PT. ST. IGNACE
Wilmette
Benton Harbor
PT. LA BARBE
STRAITS OF MACKINAC
WAUGOSHANCE PT.
IS.
MCGULPIN PT.
PT. MACKINAW
BIG STONE BAY
Chicago
Michigan City
Mackinaw City
STURGEON BAY
SOUTH CHANNEL
Gary Harbor
88°
87°
86°
85°

Chart 1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LAKE HURON
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SOUTH CHANNEL
MANITOULIN IS.
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CAPE HURD
COLLINGWOOD
SOUTHAMPTON
MACPHERSON PT.
KINCARDINE
CLARK PT.
PORT ALBERT
GODERICH
BAYFIELD
GRAND BEND
PORT FRANK
KETTLE PT.
SARNIA
LAKEPORT
LEXINGTON
SAMLAC
RICHMONDVILLE
HARBOR BEACH
PORT HOPE
HURON CITY
CASEVILLE
POINTE AUX BARQUES
SAGINAW BAY
SIX FATHOM BANK
STURGEON PT.
THUNDER BAY
ALPENA
MIDDLE IS.
ROCKPORT
PRESQUE ISLE
OSCODA
TAWAS CITY
ROGERS CITY
CHEBOYGAN
CORDWOOD PT.
MACKINAC IS.
BOIS BLANC IS.
STRS. OF MACKINAC
ST. MARYS RIVER
DRUMMOND IS.
DETOUR CH.
FALSE DETOUR CH.
MISSISSAGI STR.
DUCK IS.
OMENA CHANNEL
LUCAS CHANNEL
MCGREGOR CHANNEL
GREAT LOKOUT SHOAL
GRAVELLY SHOAL
BIG CHARITY IS.

Chart 2

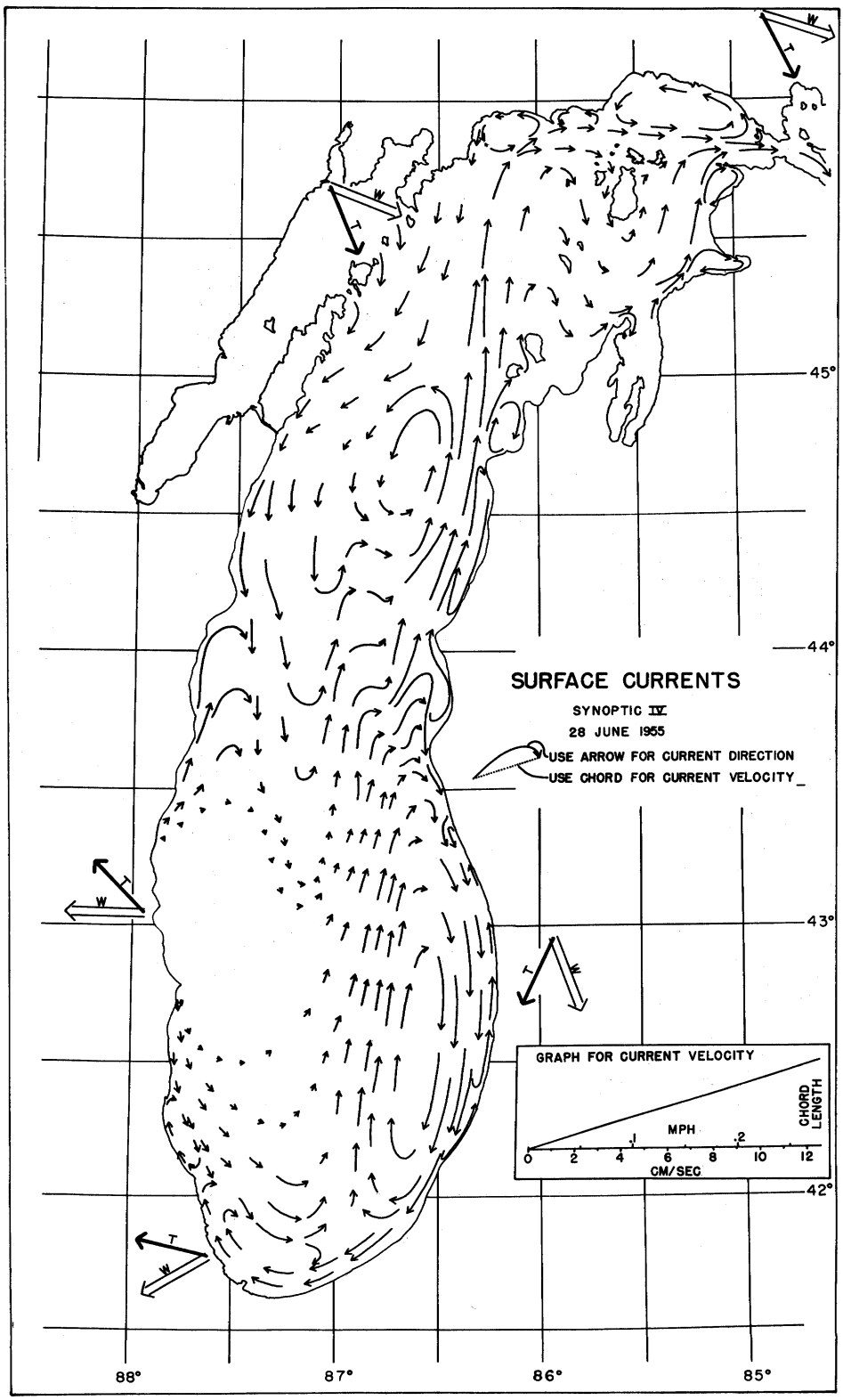
SURFACE CURRENTS
SYNOPTIC IV
28 JUNE 1955
USE ARROW FOR CURRENT DIRECTION
USE CHORD FOR CURRENT VELOCITY
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
MPH
.1
.2
0
2
4
6
8
10
12
CM/SEC
45°
44°
43°
42°
88°
87°
86°
85°

Chart 3

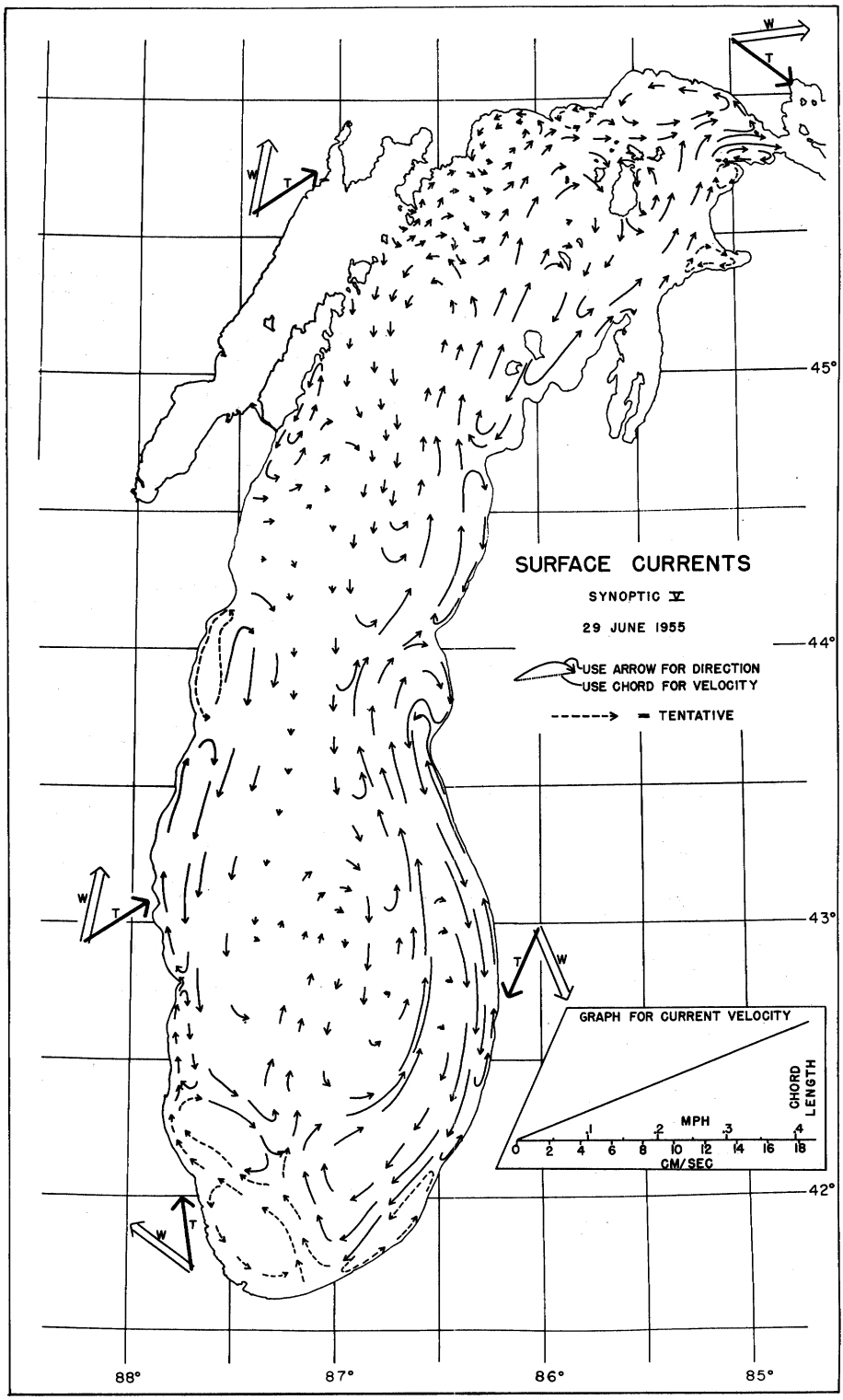
SURFACE CURRENTS
SYNOPTIC V
29 JUNE 1955
USE ARROW FOR DIRECTION
USE CHORD FOR VELOCITY
------> = TENTATIVE
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
MPH
0 2 4 6 8 10 12 14 16 18
CM/SEC
45°
44°
43°
42°
88°
87°
86°
85°
W
T

Chart 4

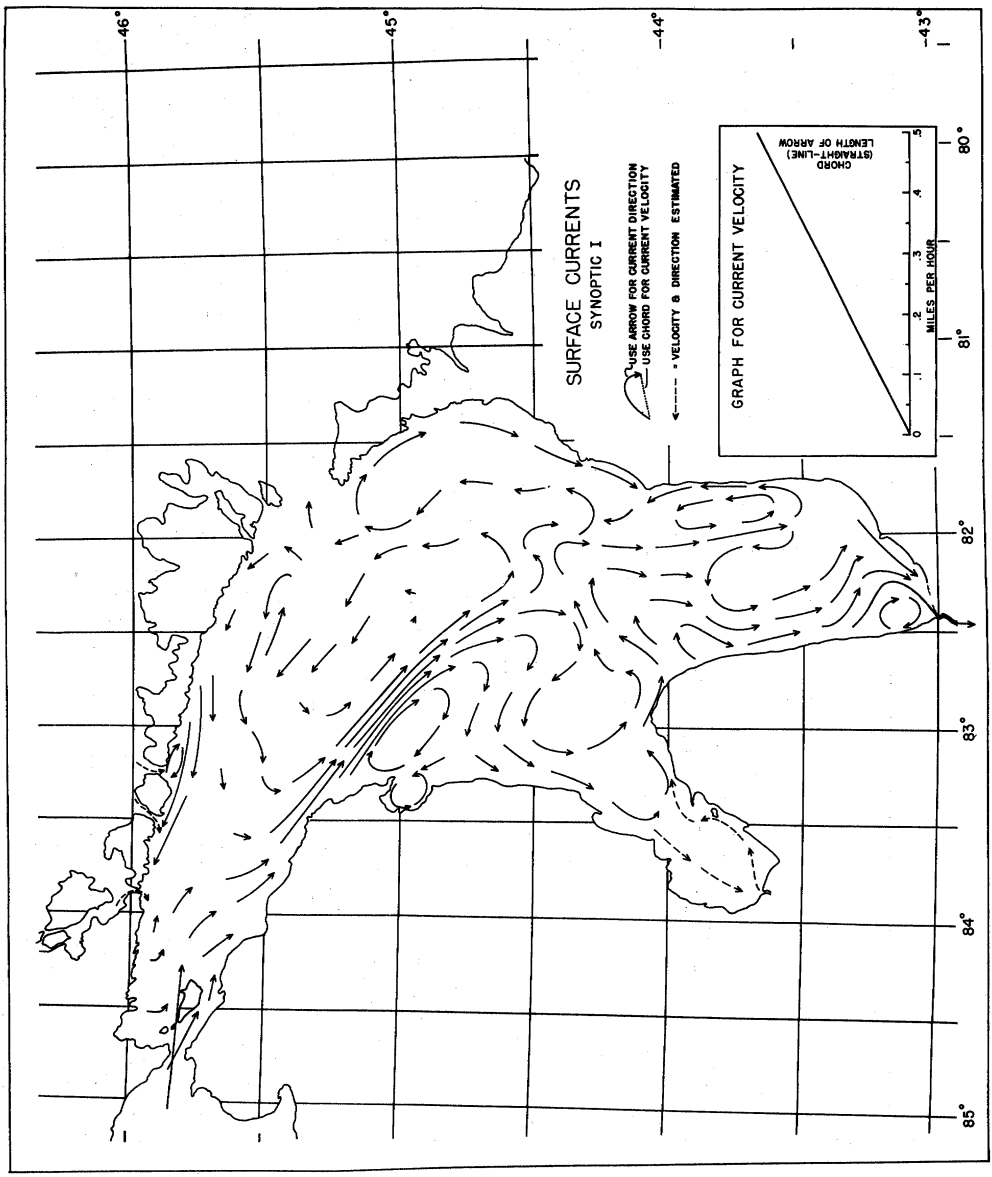
SURFACE CURRENTS
SYNOPTIC I
USE ARROW FOR CURRENT DIRECTION
USE CHORD FOR CURRENT VELOCITY
VELOCITY & DIRECTION ESTIMATED
GRAPH FOR CURRENT VELOCITY
CHORD (STRAIGHT-LINE) LENGTH OF ARROW
MILES PER HOUR
0
.1
.2
.3
.4
.5
46°
45°
44°
43°
80°
81°
82°
83°
84°
85°

Chart 5

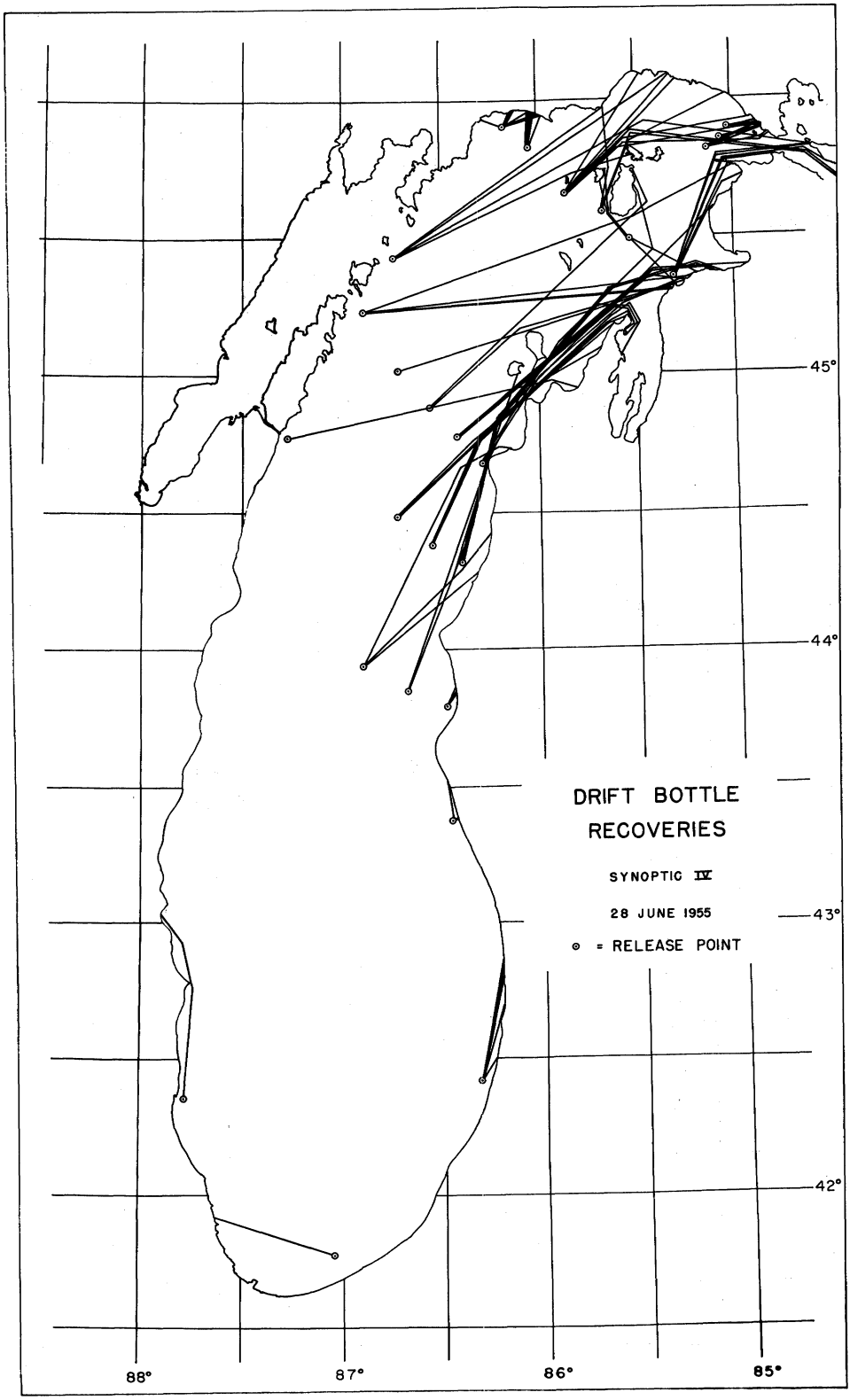
DRIFT BOTTLE
RECOVERIES
SYNOPTIC IV
28 JUNE 1955
⊙ = RELEASE POINT
45°
44°
43°
42°
88°
87°
86°
85°

Chart 6

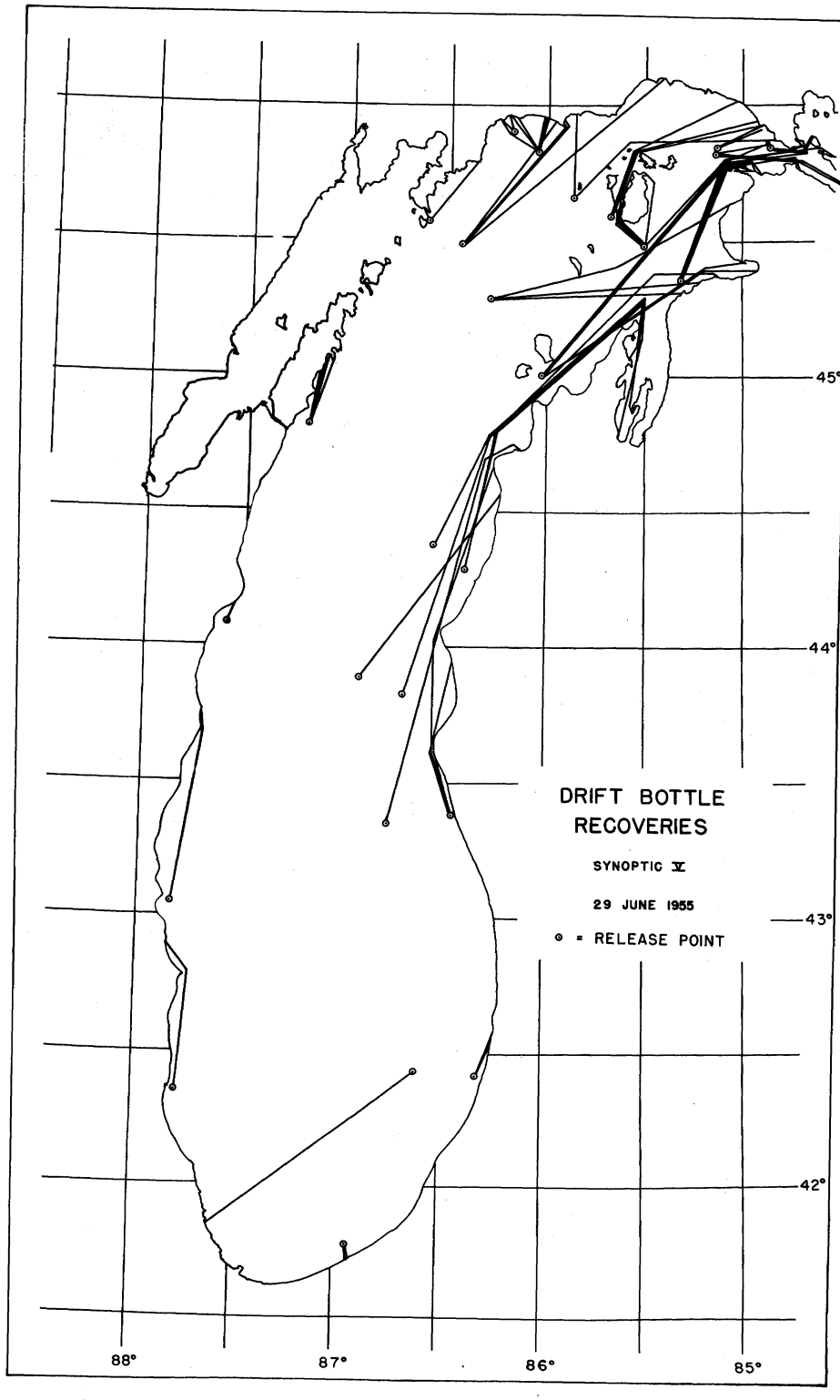
DRIFT BOTTLE
RECOVERIES
SYNOPTIC IX
29 JUNE 1955
⊙ = RELEASE POINT
45°
44°
43°
42°
88°
87°
86°
85°

Chart 7

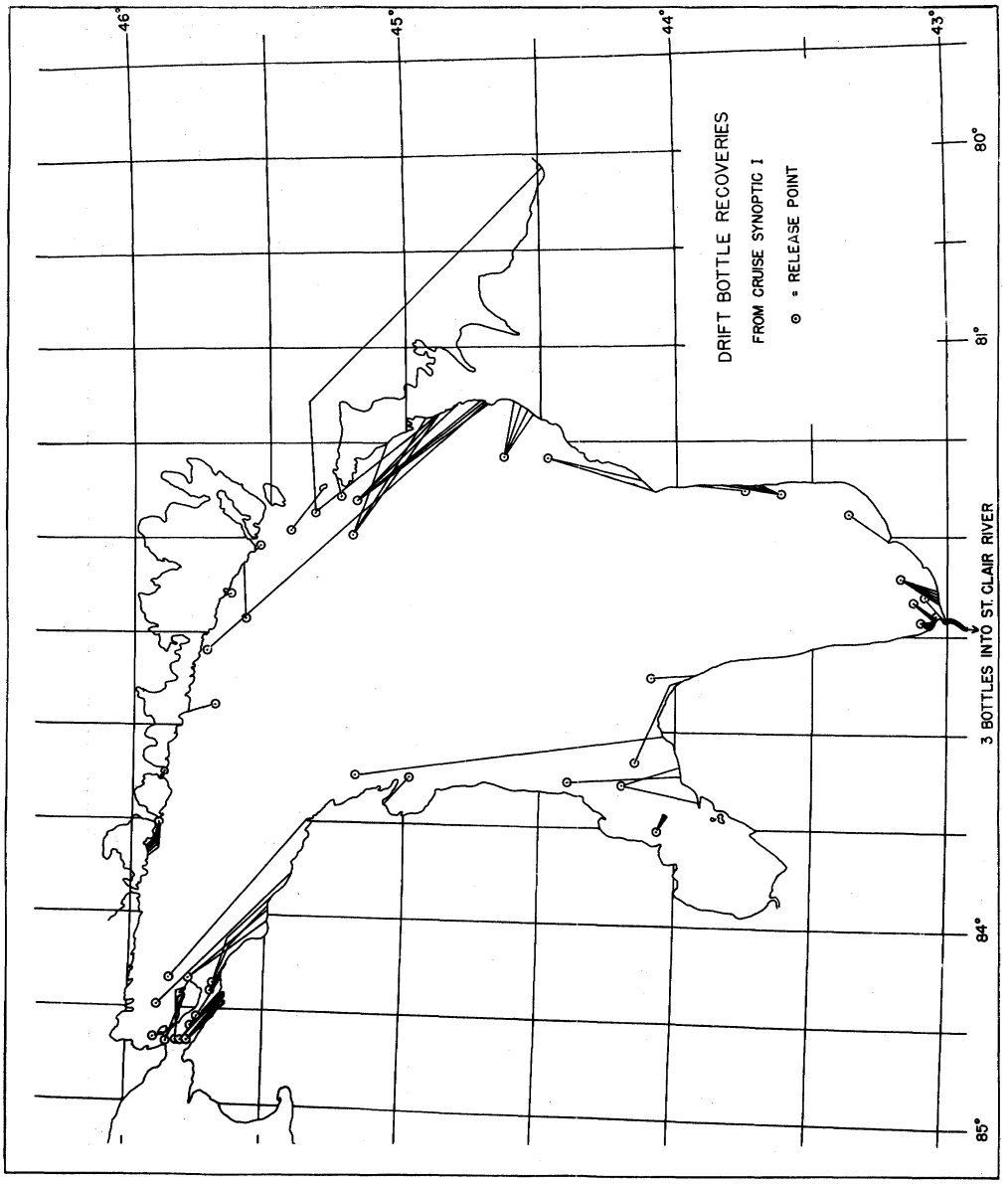
DRIFT BOTTLE RECOVERIES
FROM CRUISE SYNOPTIC 1
⊙ = RELEASE POINT
3 BOTTLES INTO ST. CLAIR RIVER
46°
45°
44°
43°
80°
81°
84°
85°

Chart 8

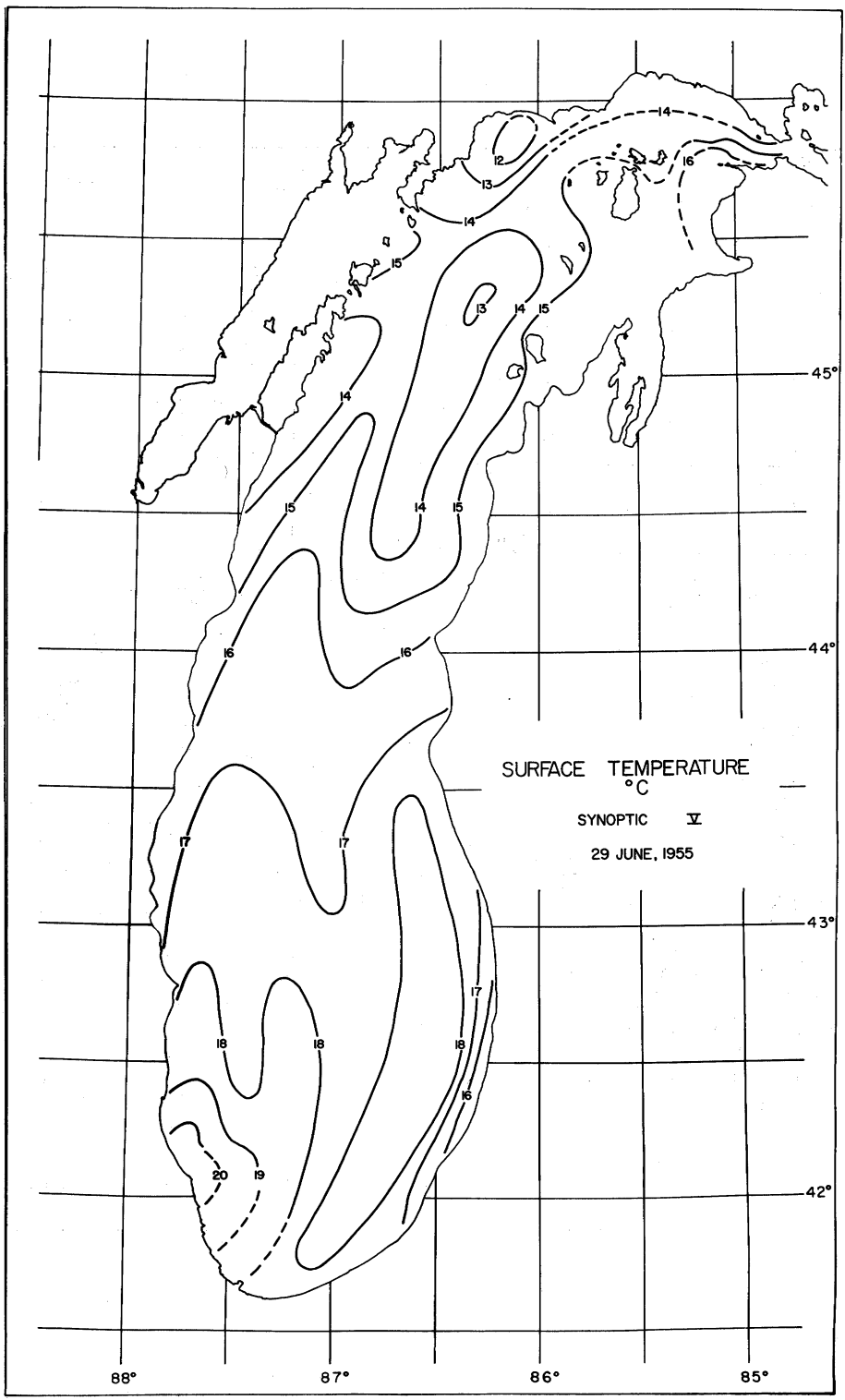
SURFACE TEMPERATURE
°C
SYNOPTIC V
29 JUNE, 1955
45°
44°
43°
42°
88°
87°
86°
85°

Chart 9

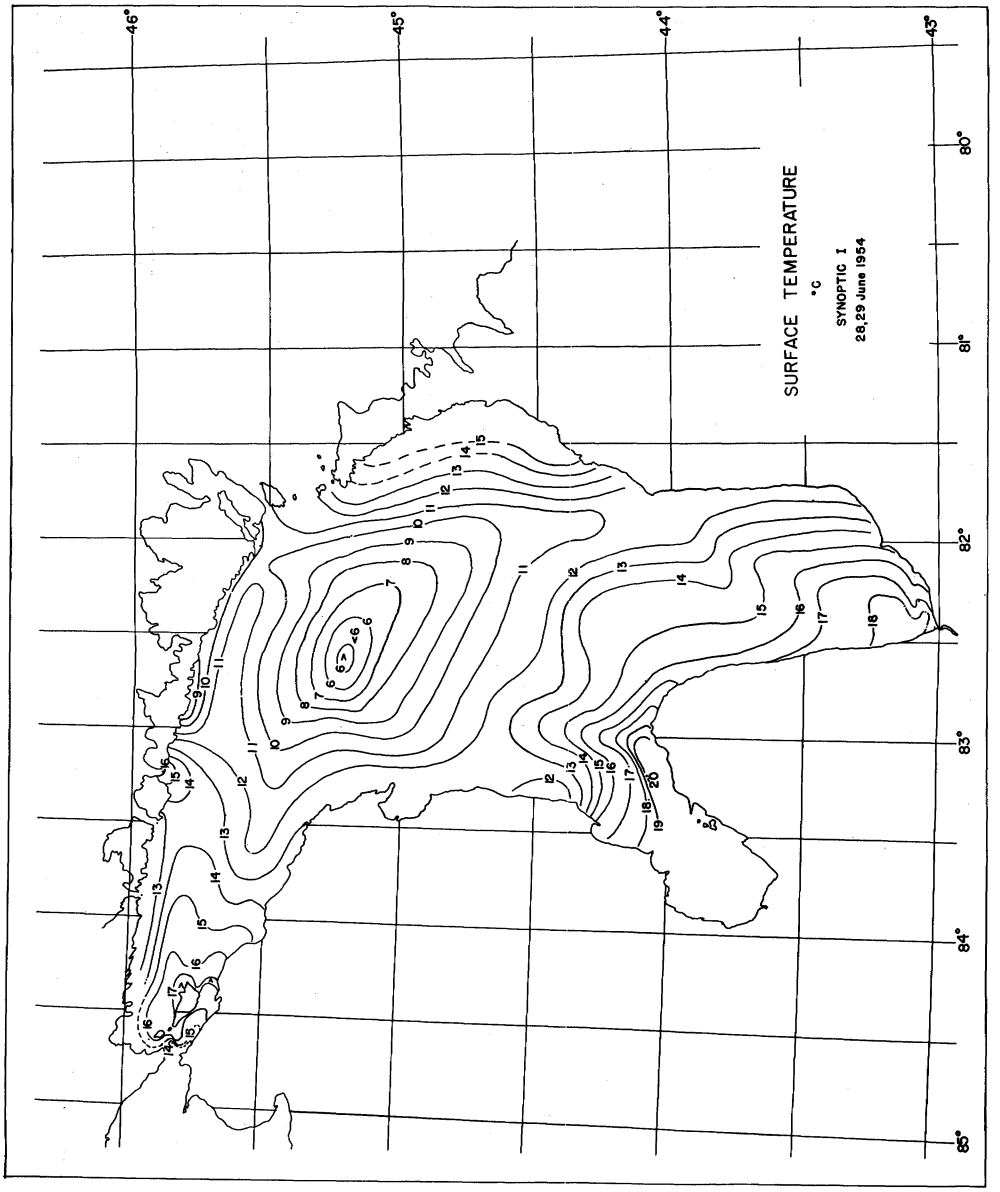
SURFACE TEMPERATURE
°C
SYNOPTIC I
28,29 June 1954
46°
45°
44°
43°
80°
81°
82°
83°
84°
85°

Chart 10

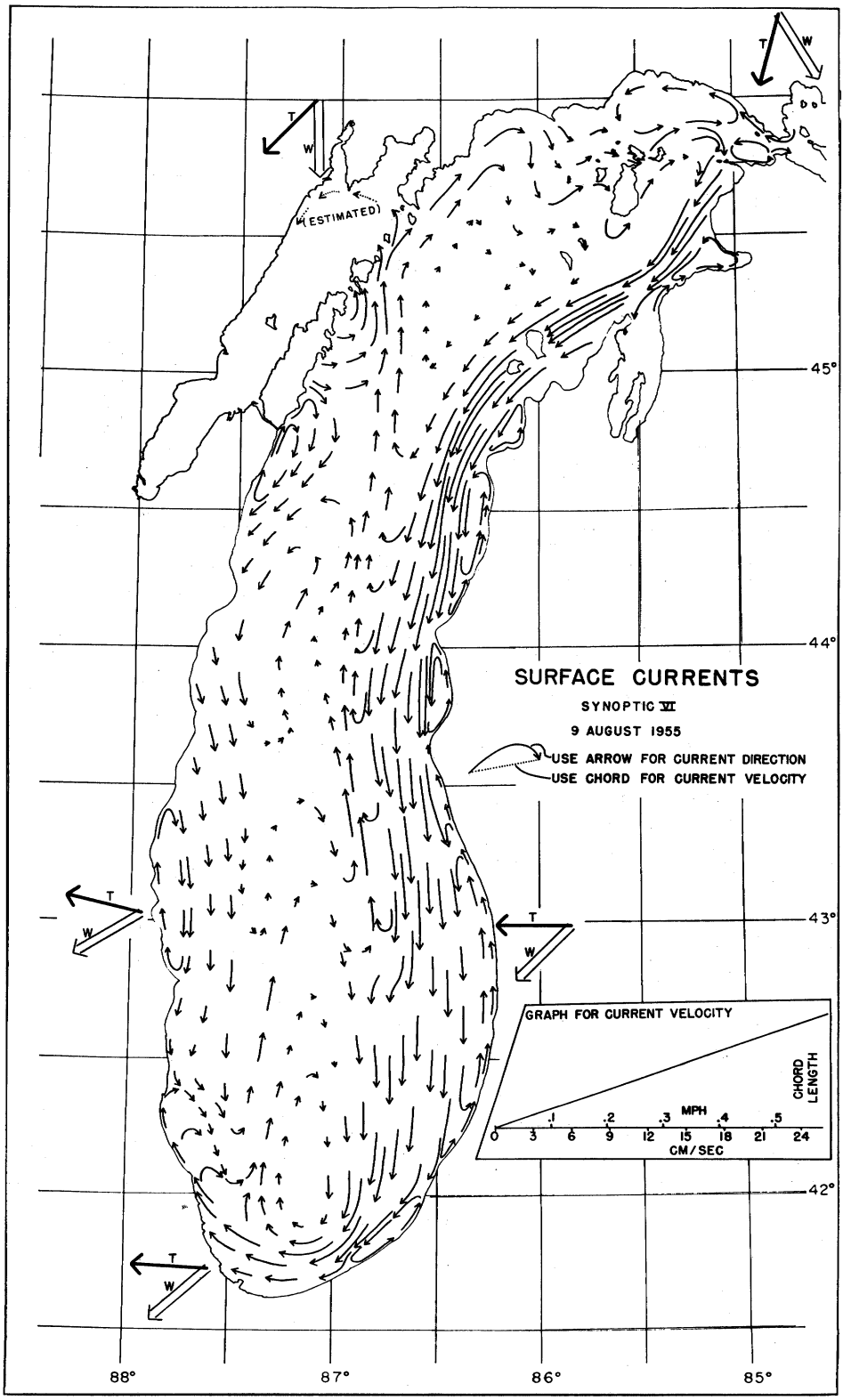
T
W
(ESTIMATED)
45°
44°
SURFACE CURRENTS
SYNOPTIC VI
9 AUGUST 1955
USE ARROW FOR CURRENT DIRECTION
USE CHORD FOR CURRENT VELOCITY
43°
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
MPH
.1
.2
.3
.4
.5
0 3 6 9 12 15 18 21 24
CM/SEC
42°
88°
87°
86°
85°

Chart 11

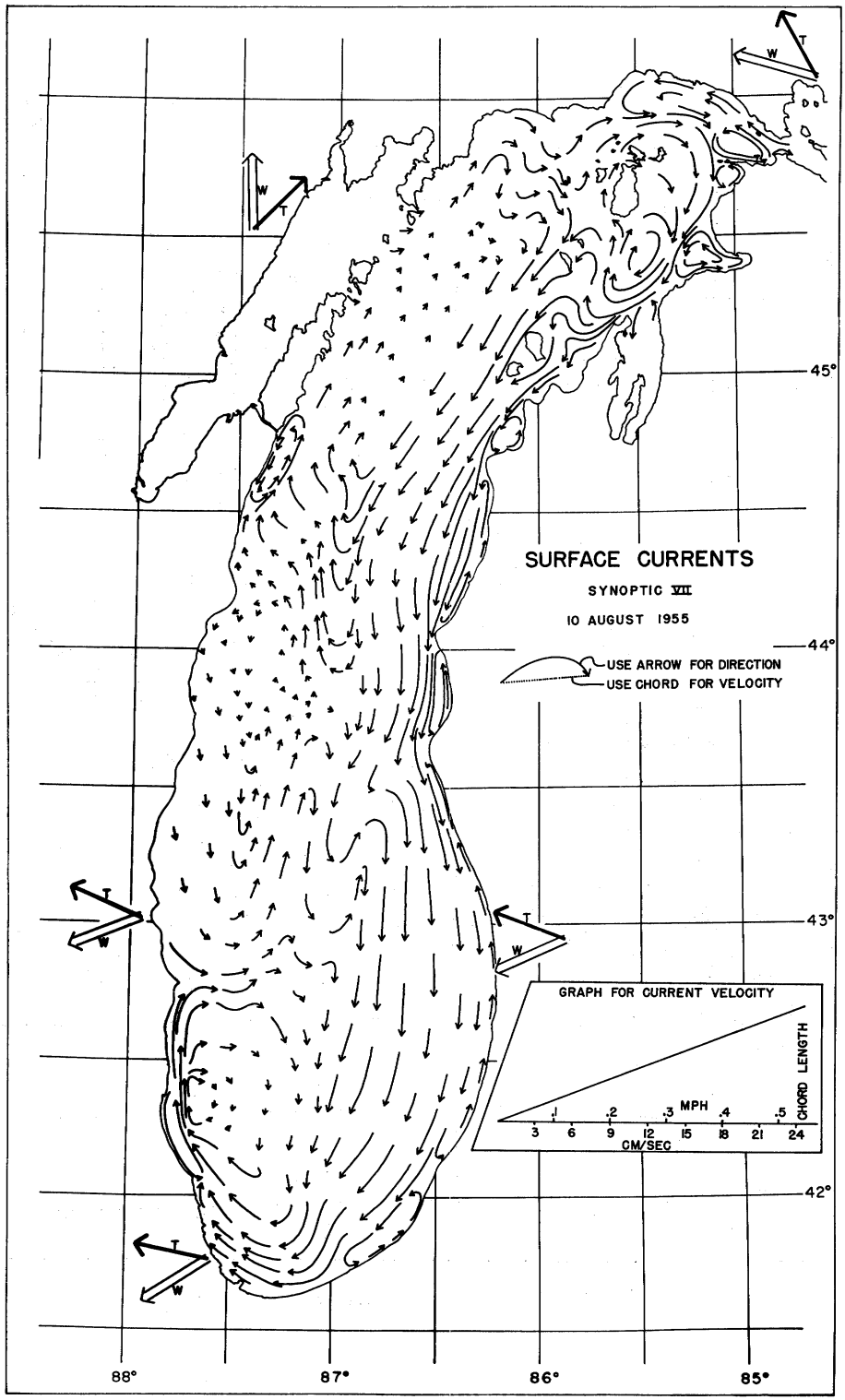
SURFACE CURRENTS
SYNOPTIC VII
10 AUGUST 1955
USE ARROW FOR DIRECTION
USE CHORD FOR VELOCITY
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
.1
.2
.3
.4
.5
MPH
3
6
9
12
15
18
21
24
CM/SEC
45°
44°
43°
42°
88°
87°
86°
85°
W
T

Chart 12

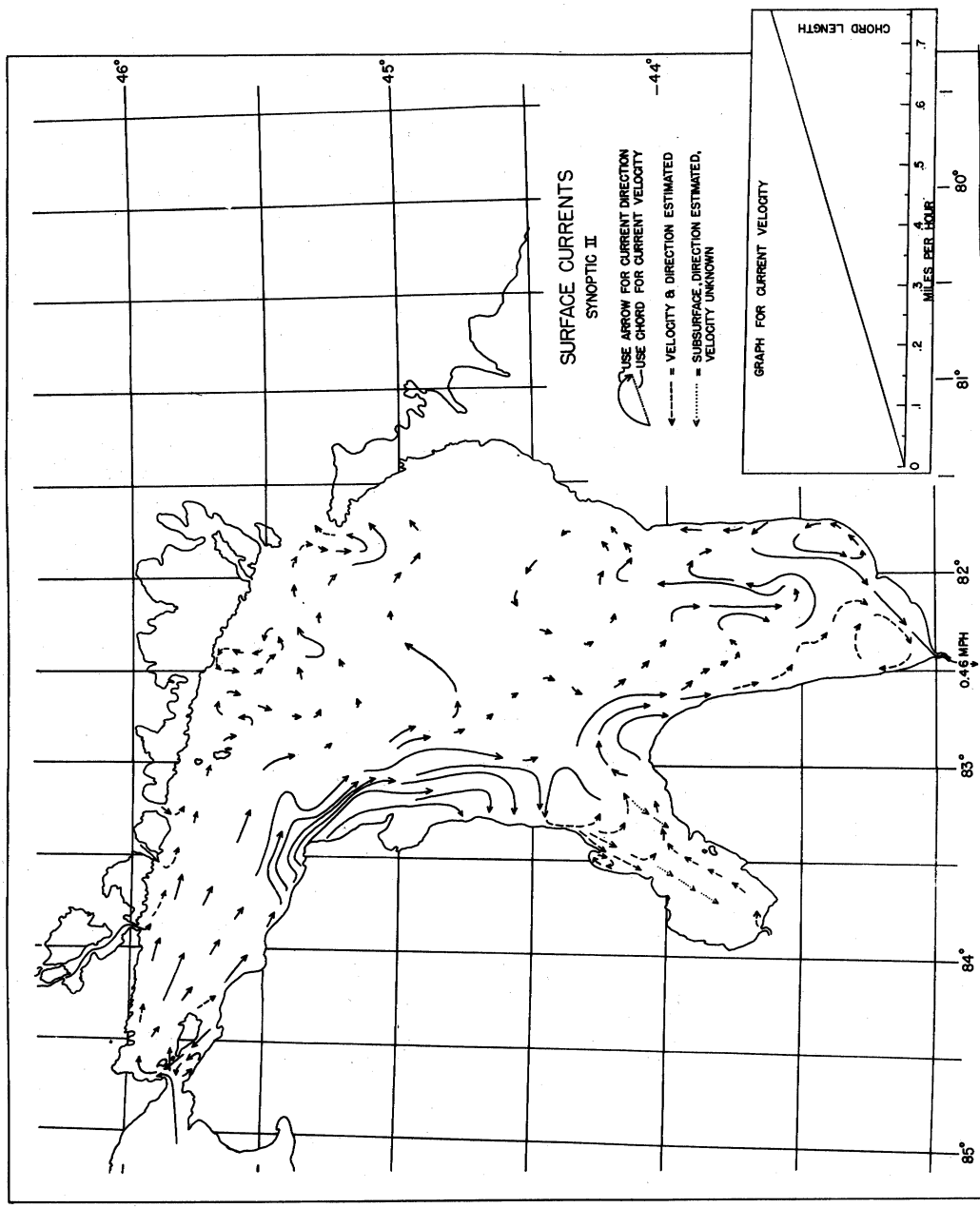
SURFACE CURRENTS
SYNOPTIC II
USE ARROW FOR CURRENT DIRECTION
USE CHORD FOR CURRENT VELOCITY
= VELOCITY & DIRECTION ESTIMATED
= SUBSURFACE, DIRECTION ESTIMATED, VELOCITY UNKNOWN
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
MILES PER HOUR
0.46 MPH
46°
45°
44°
80°
81°
82°
83°
84°
85°

Chart 13

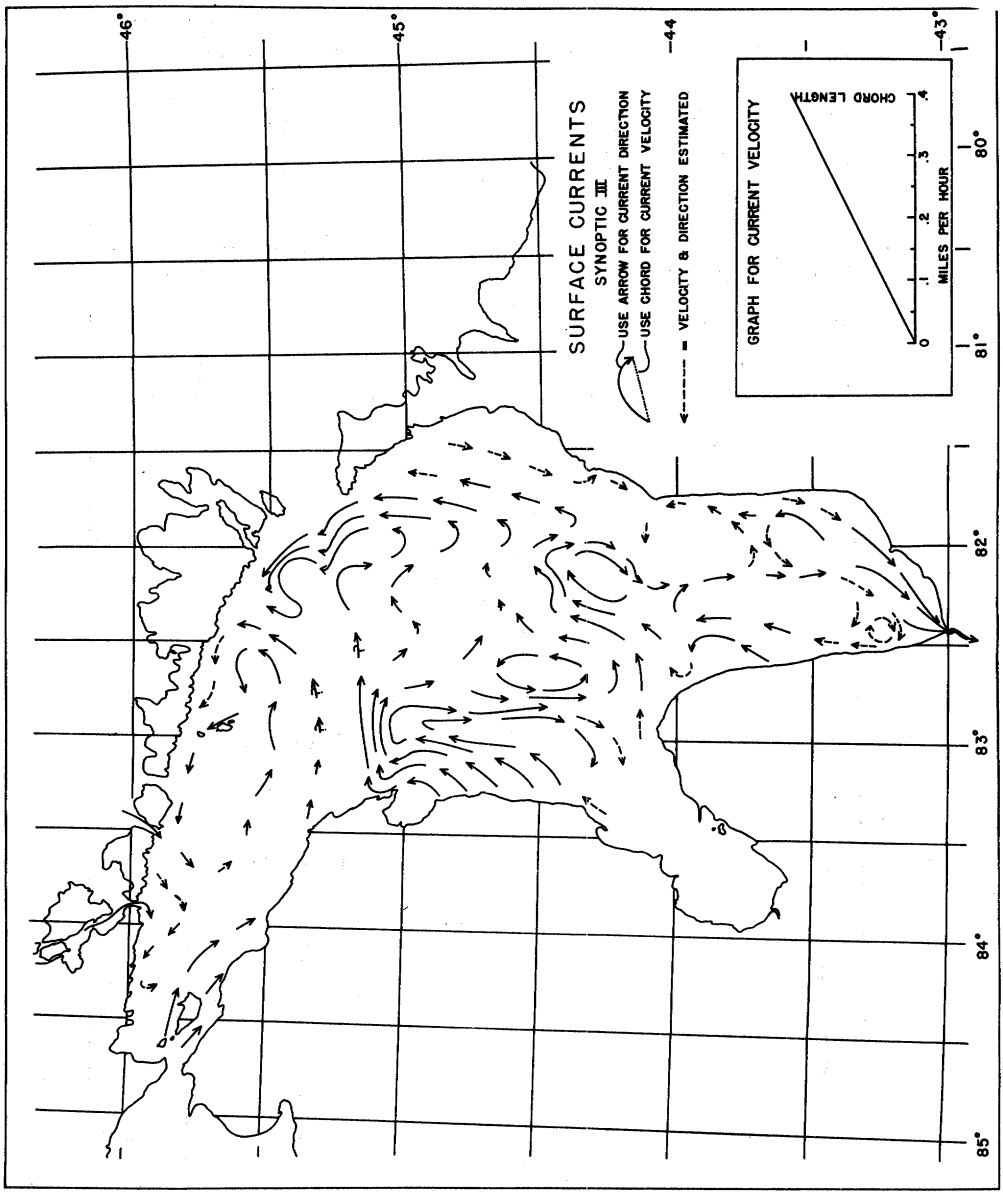
SURFACE CURRENTS
SYNOPTIC III
USE ARROW FOR CURRENT DIRECTION
USE CHORD FOR CURRENT VELOCITY
= VELOCITY & DIRECTION ESTIMATED
GRAPH FOR CURRENT VELOCITY
CHORD LENGTH
0
.1
.2
.3
.4
MILES PER HOUR
46°
45°
44
43°
80°
81°
82°
83°
84°
85°

Chart 14

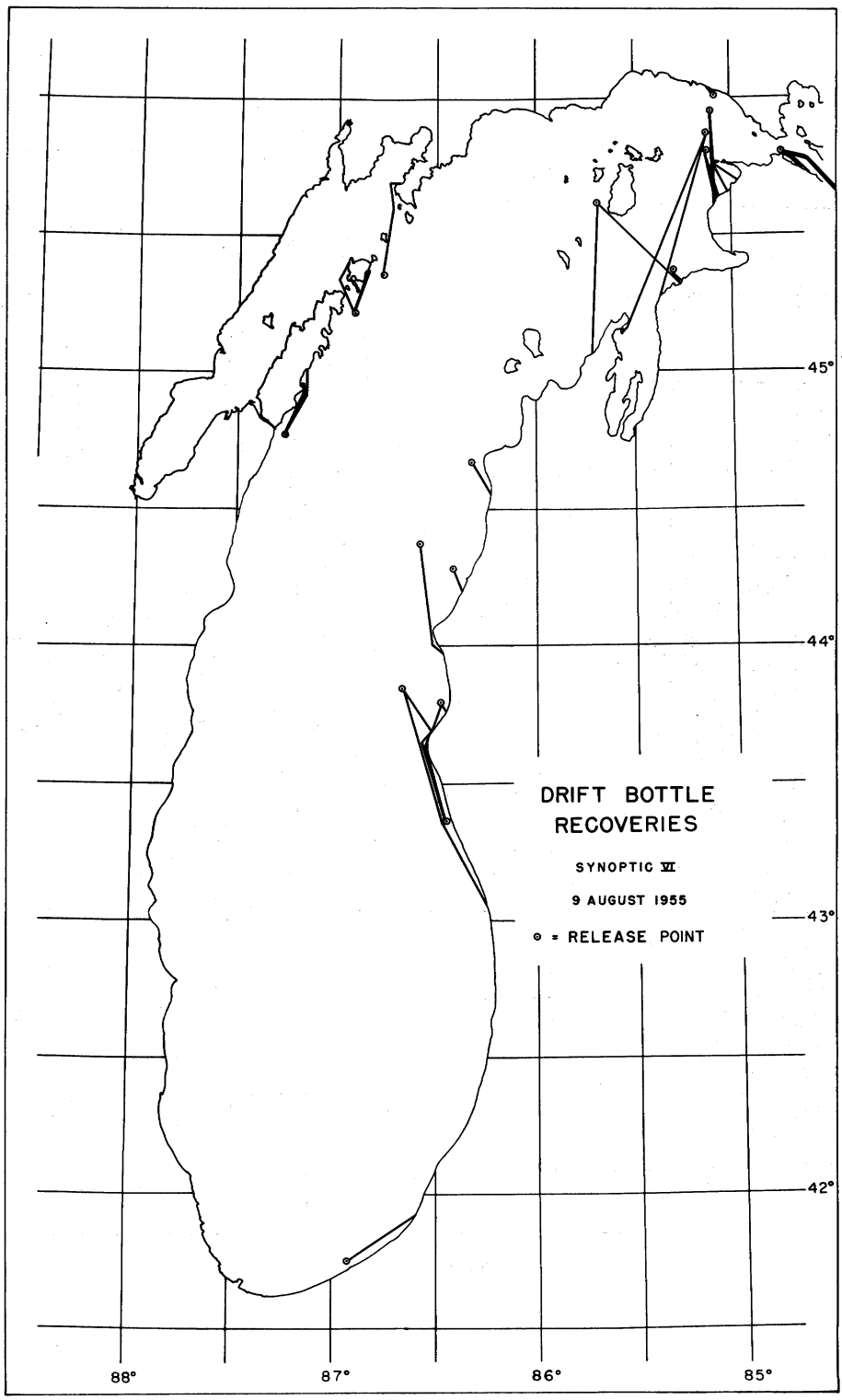
DRIFT BOTTLE
RECOVERIES
SYNOPTIC VII
9 AUGUST 1955
⊙ = RELEASE POINT
45°
44°
43°
42°
88°
87°
86°
85°

Chart 15

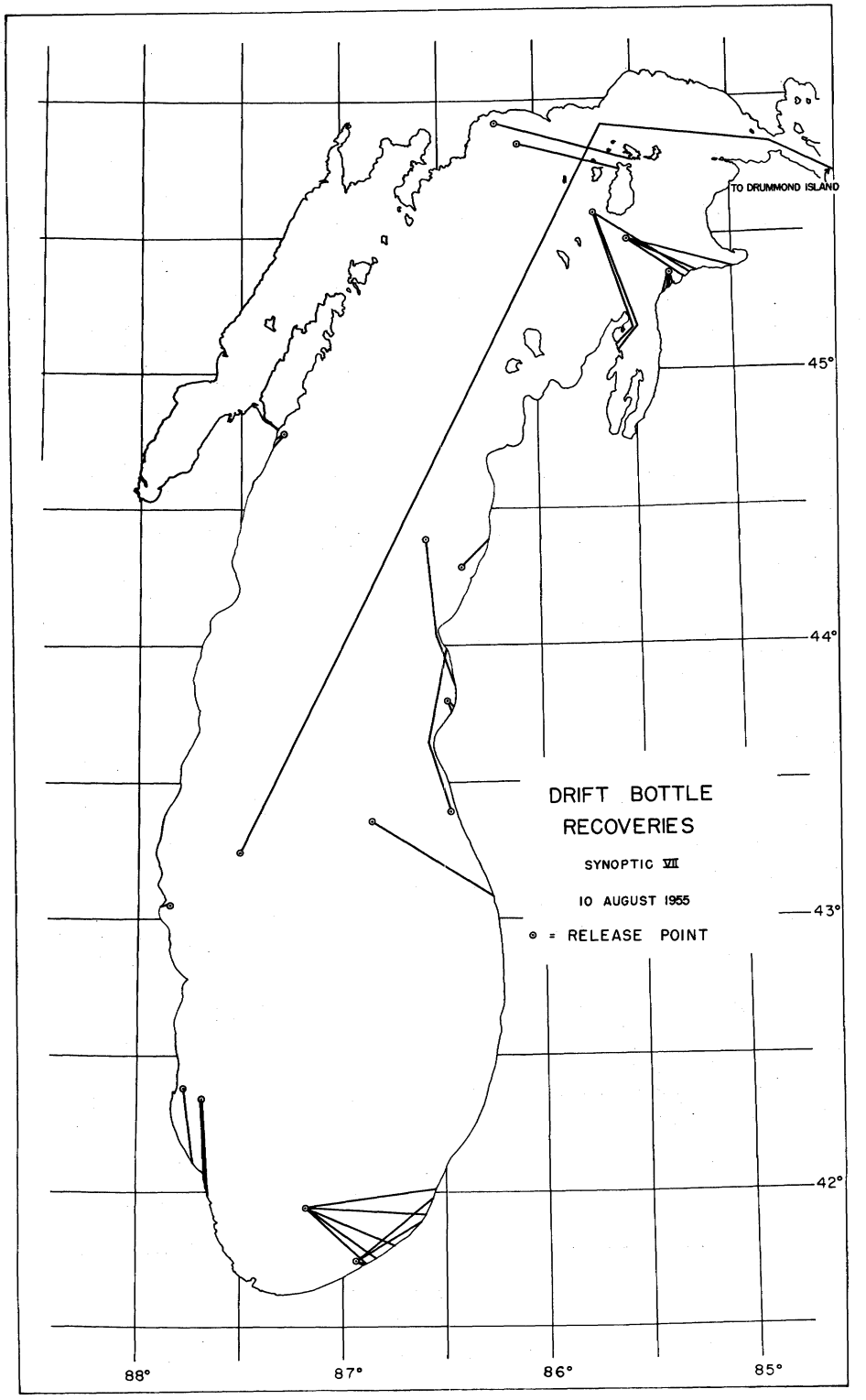
TO DRUMMOND ISLAND
45°
44°
43°
42°
88°
87°
86°
85°
DRIFT BOTTLE
RECOVERIES
SYNOPTIC VII
10 AUGUST 1955
⊙ = RELEASE POINT

Chart 16

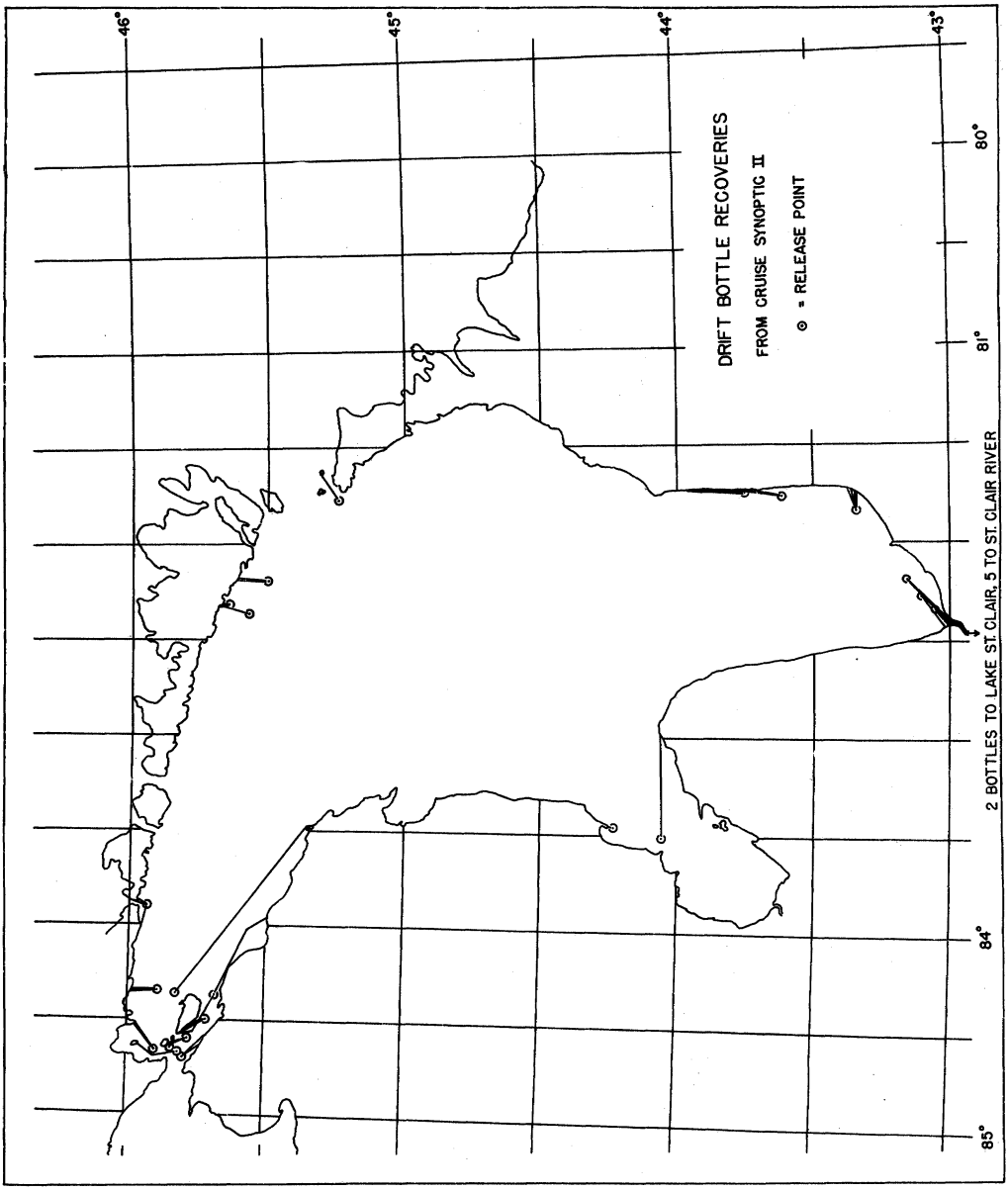
DRIFT BOTTLE RECOVERIES
FROM CRUISE SYNOPTIC II
⊙ = RELEASE POINT
2 BOTTLES TO LAKE ST. CLAIR, 5 TO ST. CLAIR RIVER
46°
45°
44°
43°
80°
81°
84°
85°

Chart 17

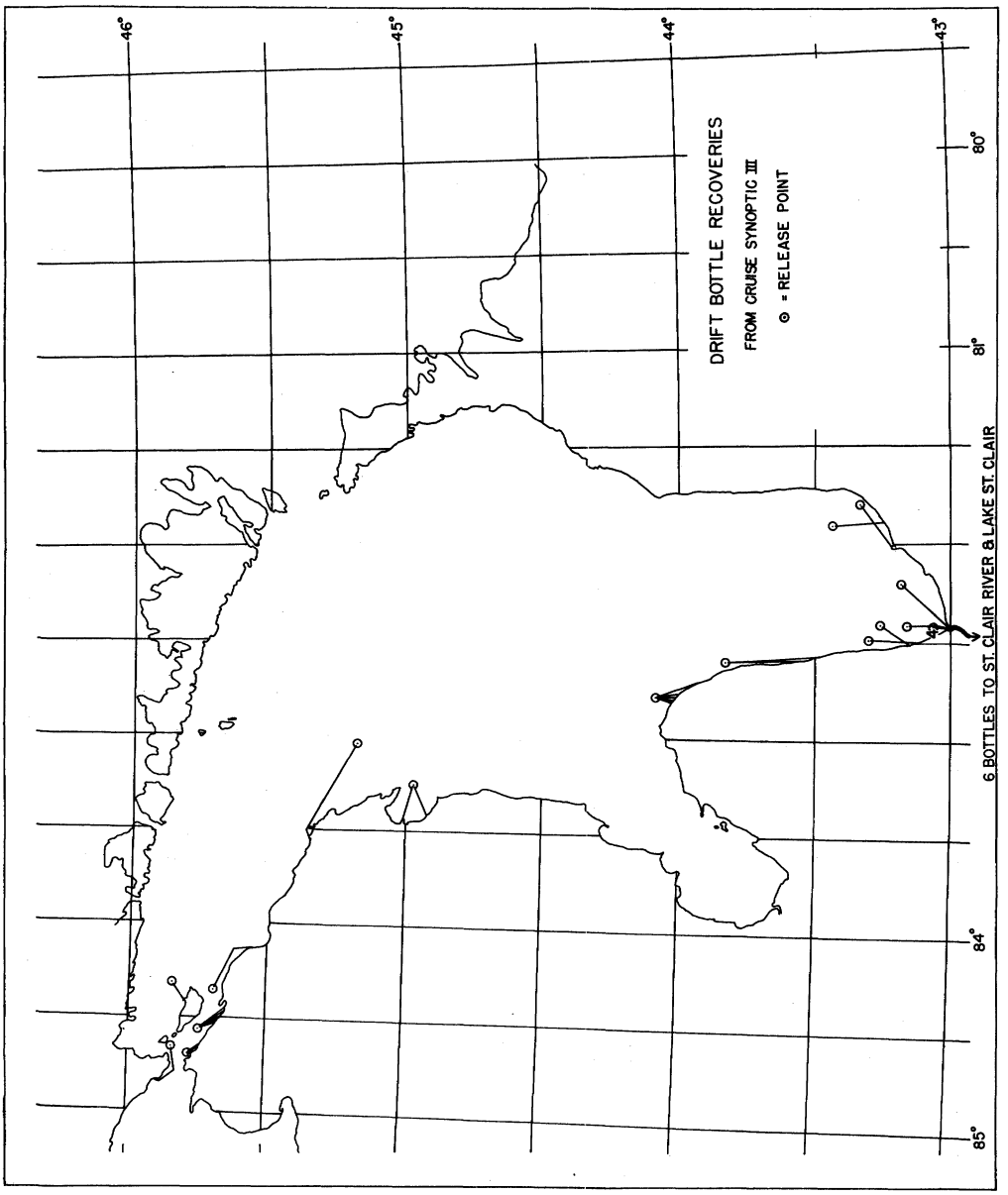
DRIFT BOTTLE RECOVERIES
FROM CRUISE SYNOPTIC III
⊙ = RELEASE POINT
6 BOTTLES TO ST. CLAIR RIVER & LAKE ST. CLAIR
46°
45°
44°
43°
80°
81°
84°
85°

Chart 18

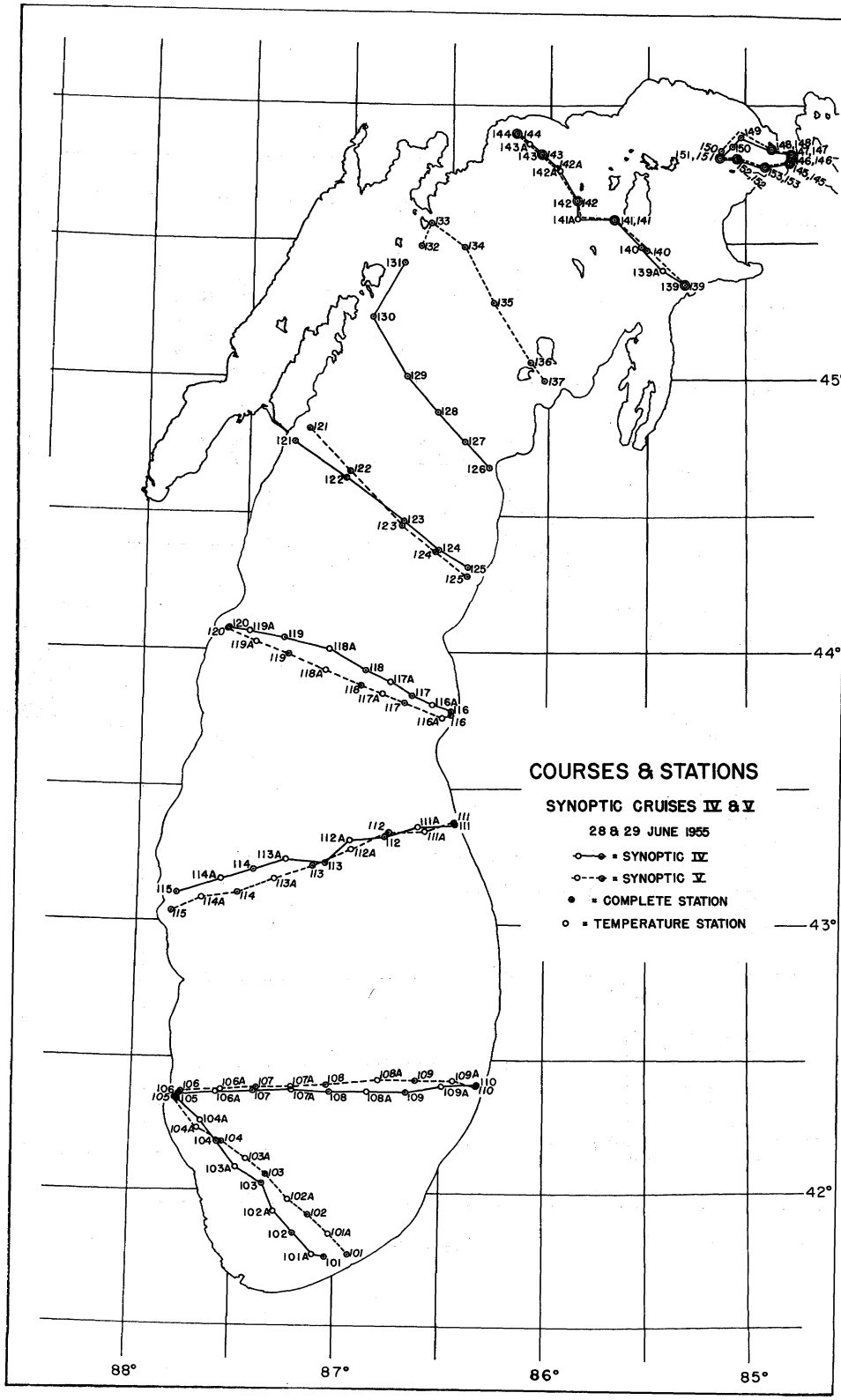
COURSES & STATIONS
SYNOPTIC CRUISES IV & V
28 & 29 JUNE 1955
= SYNOPTIC IV
= SYNOPTIC V
= COMPLETE STATION
= TEMPERATURE STATION
45°
44°
43°
42°
88°
87°
86°
85°

Chart 19

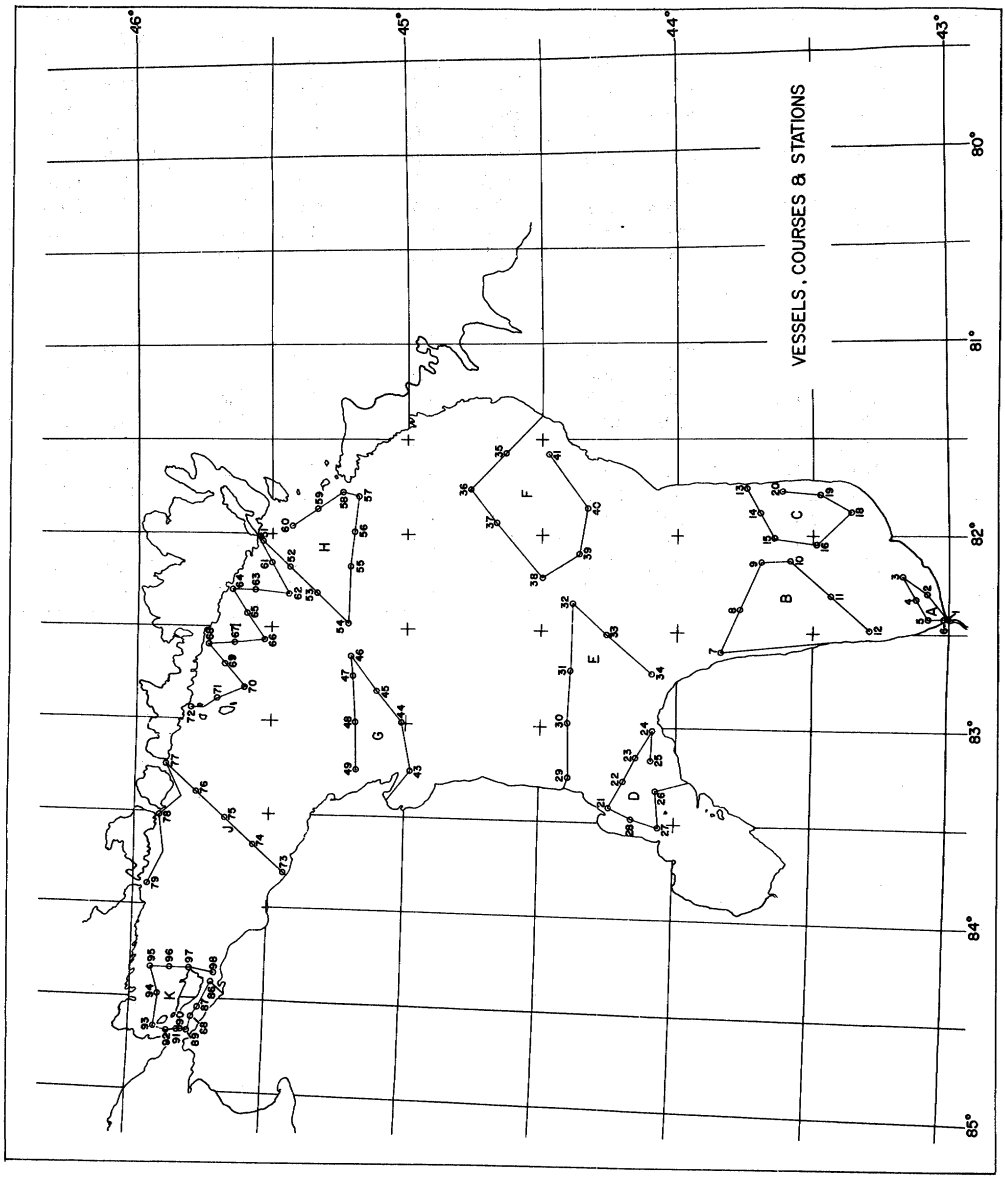

Chart 20

Table 1. Wind data, Lake Michigan, 1955.

Dir. = prevailing direction; mph = average velocity, mph.

Date	Chicago		Milwaukee		Grand Rapids		Escanaba		Sault Ste.Marie	
	Dir.	mph	Dir.	mph	Dir.	mph	Dir.	mph	Dir.	mph
29 June	SSW	10.4	SSW	13.1	SSW	6.8	S	9.3	SE	5.4
28	S	8.1	SSW	12.4	NW	3.5	S	9.2	SW	5.1
27	ENE	7.0	ESE	8.1	NW	2.4	S	7.1	W	7.5
26	ENE	7.1	ENE	6.3	N	6.1	NW	6.2	WNW	9.6
25	NE	9.6	ENE	9.4	NNW	5.5	N	11.5	NW	9.3
24	E	6.9	W	8.6	WNW	6.0	N	7.6	WNW	8.6
23	NW	8.5	WNW	11.0	WNW	5.6	S	5.7	WNW	9.3
22	NW	10.9	WNW	17.7	NW	9.3	NW	13.6	WNW	12.8
21	NW	10.8	WNW	15.1	WNW	8.4	NW	11.1	WNW	10.9
20	WNW	6.6	SW	8.1	W	4.3	S	7.7	SW	5.9
19	SW	9.2	S	5.9	ESE	3.1	S	8.0	SW	7.4
10 August	E	4.7	WNW	9.8	WNW	4.3	NW	9.3	WNW	7.5
9	E	5.8	ESE	8.6	E	5.2	S	9.4	SE	8.4
8	ENE	9.8	ENE	14.2	E	8.3	S	6.5	ENE	5.2
7	NNE	12.7	NE	20.1	N	10.0	N	16.8	NW	12.7
6	WNW	8.3	SSW	8.6	S	6.1	N	6.1	ESE	7.1
5	SW	7.5	SW	9.8	W	8.2	N	10.2	WNW	8.4
4	SW	10.4	SW	13.1	W	9.0	S	6.5	WNW	7.6
3	SW	10.1	SW	12.1	W	7.1	S	6.6	SE	4.8
2	E	6.0	E	6.3	WNW	4.6	N	6.2	WNW	5.5
1	E	6.7	NNE	7.2	NW	5.4	S	7.1	WNW	5.2
31 July	S	6.3	SW	9.8	W	4.5	SW	7.5	SW	6.8

Table 2. Wind data, Lake Huron, 1954.

Dir. = prevailing direction; mph = average velocity, mph

Date	Sault Ste. Marie Dir.	mph	Alpena Dir.	mph	Detroit Dir.	mph
29 June	ESE	7.4	SE	7.7	N	3.8
28	WNW	4.6	NW	6.6	N	10.1
27	WNW	12.5	NW	17.0	NNW	14.3
26	WNW	8.6	NW	8.0	NW	11.3
25	ESE	3.5	S	4.7	WSW	10.7
24	SSW	8.5	SW	7.4	S	7.2
23	WNW	7.0	NW	9.3	NNW	10.8
22	WNW	9.1	W	10.5	WNW	14.6
21	E	5.4	SE	8.1	SW	10.1
20	SW	9.1	S	9.3	SSW	8.0
19	WNW	4.2	SE	5.1	S	8.3
27 July	SSW	4.8	SW	7.0	WNW	7.8
26	WNW	6.7	W	7.7	N	5.2
25	WNW	8.4	NW	8.7	NE	5.6
24	WNW	8.7	NW	6.8	N	4.9
23	WNW	4.3	NW	7.6	N	4.1
22	NW	7.6	N	6.8	NE	8.6
21	WNW	7.6	N	7.8	NNE	10.5
20	WNW	7.3	N	8.8	SW	11.0
19	SE	6.0	SE	10.1	NW	7.5
18	WNW	9.4	NW	11.3	S	9.2
17	E	7.3	S	6.3	SSE	6.3
25 August	W	7.6	W	9.8	W	8.4
24	WNW	5.3	W	6.0	W	10.7
23	ESE	8.7	S	8.7	S	6.8
22	ESE	8.6	SE	8.4	E	7.7
21	WNW	4.8	SE	6.8	ENE	7.0
20	WNW	7.8	NW	7.1	N	7.1
19	WNW	9.9	NW	10.3	W	9.7
18	E	6.9	S	11.7	SSE	6.5
17	WNW	7.9	NW	8.3	N	6.6
16	NW	12.0	NW	13.4	W	9.5
15	W	6.1	NW	7.3	W	8.3

Table 3. Drift bottle data, Cruise Synoptic IV, 28 June 1955.

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
3396	101	41°55.1',87°37.2'	12VII55	14	32	0.10
3360	105	43°00.9',87°53.2'	20VII55	22	50	0.09
3298	110	42°40.3',86°13.0'	5VII55	7	20	0.12
3297	110	42°49.8',86°12.8'	5VII55	7	30	0.18
3295	110	42°50.7',86°12.9'	6VII55	8	31	0.16
3294	110	42°47.2',86°12.9'	8VII55	10	27	
3291	110	42°28.9',86°14.8'	1VII55	3	7	0.10
2924	111	43°31.0',86°28.8'	2VII55	4	10	0.10
2923	111	43°22.3',86°25.8'	29VI55	1	1	0.04
2922	111	43°22.3',86°25.8'	30VI55	2	1	0.02
2619	116	43°51.2',86°25.9'	28VI55	0*	5	ca 0.40
2617	116	43°50.0',86°25.9'	28VI55	0*	4	ca 0.30
2616	116	43°50.0',86°25.9'	29VI55	1	4	0.17
2485	117	45°03.7',86°00.0'	17VII55	19	91	0.20
2481	117	45°00.0',86°06.6'	18VII55	20	85	0.18
2599	118	44°16.4',86°19.1'	26VII55	28	37	
2598	118	44°25.1',86°15.1'	15VII55	17	47	0.12
2477	118	44°43.6',86°09.4'	18VII55	20	68	0.14
2505	121	44°56.8',85°48.8'	3IX55	67	74	0.05
2510	121	45°06.8',85°36.0'	15VII57	-	-	
2528	123	45°04.5',85°35.8'	23VII55	25	90	0.15
2527	123	45°05.2',85°41.3'	23VII55	25	66	0.11
2523	123	45°10.4',85°37.9'	24VII55	26	72	0.12
2533	124	45°11.4',85°31.8'	22VII55	24	79	
2535	124	45°12.2',85°33.5'	10VII55	12	76	0.26
2537	124	45°35.7',85°06.4'	25VII55	27	112	
2544	125	45°08.2',85°33.8'	8VIII55	41	90	
2543	125	45°21.8',85°06.5'	17VII55	19	107	0.23
2545	125	45°21.8',85°05.2'	11VIII55	44	110	

*Calculated as 1/2 day.

Table 3 (cont.)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2727	126	45°40.8',85°30.3'	22VII55	24	81	0.14
2728	126	45°21.3',85°11.7'	11VII55	13	75	0.24
2734	127	45°20.2',85°14.1'	10VII55	12	61	0.21
2706	127	45°23.5',84°54.9'	11VII55	13	90	0.29
2707	127	45°09.8',85°33.4'	8VII55	10	62	0.26
2733	127	45°21.8',85°05.5'	2VIII55	35	80	
2714	128	45°20.2',85°14.7'	16VII55	18	73	0.17
2715	128	45°44.7',85°30.0'	7VIII55	40	83	
2718	129	45°18.8',85°17.2'	27VII55	29	73	0.10
2813	130	45°45.1',84°59.3'	8VIII55	41	100	0.10
2812	130	45°19.2',85°17.0'	31VII55	33	78	0.10
2662	130	45°21.4',85°11.4'	9VIII55	42	83	0.08
2661	130	45°18.2',85°19.0'	31VII55	33	78	0.10
2693	131	Lime Kiln Pt., Bois Blanc Is.	1X55	95	113	
2694	131	45°57.9',85°39.8'	30VII55	32	65	0.08
2234	131	45°48.3',85°31.3'	14XII55	169	65	
2233	131	46°05.6',85°19.8'	1IX55	65	82	
2107	139	Lime Kiln Pt., Bois Blanc Is.	31VII55	33	55	
2109	139	Lime Kiln Pt., Bois Blanc Is.	30VIII55	63	57	
2832	139	45°43.4',84°56.7'	---	--	--	---
2835	139	45°47.3',84°45.7'	14VII55	16	46	0.12
2831	139	45°45.9',85°01.1'	10VII55	12	31	0.11
2108	139	South shore, Bois Blanc Is.	12VII55	14	65	0.19
2833	139	45°43.4',84°56.7"	16VII55	18	32	
2825	140	45°44.6',85°39.5'	9VII55	11	19	0.07
2420	140	45°41.9',85°40.4'	19VIII55	52	16	
2417	140	45°21.4',85°11.4'	---	--	--	---
2416	140	45°18.4',85°17.2'	24VII55	26	17	
2826	141	46°00.8',85°01.9'	16VII55	18	45	0.10
3978	141	Grace Harbor, Hammond Bay	3VIII55	36	96	0.11
2829	141	45°58.0',85°39.3'	24VIII55	57	26	

Table 3 (cont)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
3974	142	46°04.1',85°17.9'	17VII55	19	39	0.08
3981	142	45°53.0',84°48.8'	10VII55	12	56	0.19
3982	142	46°05.3',85°19.9'	---	--	--	---
2839	142	45°55.2',84°54.7'	25VII55	27	51	0.08
2837	142	45°53.8',84°51.0'	28VII55	30	53	
3976	142	46°05.6',85°28.4'	2V56	309	35	
2838	142	Hammond Bay, Lake Huron	24VII55	26	97	0.16
2466	143	45°57.7',86°02.4'	29VII55	31	9	
2467	143	45°57.7',86°02.4'	29VII55	31	9	
2468	143	45°57.7',86°02.4'	29VII55	31	9	
3973	143	45°57.7',86°02.4'	29VII55	31	9	
2470	143	45°57.6',86°01.4'	5VII55	7	9	0.05
2469	143	45°56.8',85°59.0'	22VIII55	55	9	
2857	144	45°56.8',85°59.0'	22VIII55	55	10	
2859	144	45°57.8',86°07.1'	22VII55	24	5	
2426	144	45°57.1',86°09.3'	11VIII55	44	3	
2430	144	45°56.1',86°16.9'	17VII55	19	5	0.01
2428	144	45°57.6',86°07.9'	11VII55	13	4	0.01
2429	144	45°57.8',86°03.0'	12VII55	14	7	0.02
2856	144	45°56.9',85°59.7'	27VII55	29	9	
2858	144	45°57.2',86°00.5'	29VII55	31	9	
3970	149	45°53.7',84°50.7'	1VII55	3	9	0.13
3969	149	45°54.8',84°52.8'	2VII55	4	7	0.07
3971	149	45°54.2',84°52.2'	20VII55	22	8	
3966	149	45°54.2',84°52.2'	15IX55	79	8	
3953	150	45°53.7',84°50.7'	1VII55	3	9	0.13
3949	150	45°53.7',84°50.7'	1VII55	3	9	0.13
3962	151	45°54.2',84°52.2'	1VII55	3	14	0.19
3961	151	45°54.2',84°52.2'	5VII55	7	14	0.08
3965	151	45°52.1',84°49.4'	28VII55	30	15	
3963	151	45°53.8',84°51.0'	28VII55	30	15	
3964	151	45°53.8',84°51.0'	27VII55	29	15	

Table 4. Drift bottle data, Cruise Synoptic V, 29 June 1955.

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
3339	101	41°43.2',86°55.7'	6VII55	7	3	0.02
3400	101	41°43.3',86°55.2'	6VII55	7	3	0.02
2932	105	42°54.8',87°50.5'	28VII55	29	41	0.06
3340	109	41°49.8',87°36.1'	10VIII55	42	65	0.06
3296	110	42°31.4',86°14.8'	3VII55	4	10	0.10
3290	110	42°34.0',86°14.4'	---	--	--	---
2983	111	43°56.2',86°27.5'	21VII55	22	41	
2981	111	43°37.3',86°32.2'	1VII55	2	18	0.37
2982	111	44°39.6',86°15.1'	19VII55	20	61	
2978	112	44°43.3',86°07.9'	12VIII55	44	107	0.10
2904	115	43°44.4',87°43.1'	13VII55	14	49	0.15
2496	117	45°23.2',85°07.5'	19VIII55	51	142	0.12
2640	118	44°33.4',86°13.9'	10VII55	11	58	0.22
2630	120	44°09.0',87°33.2'	29VI55	0*	5	ca 0.40
2547	121	45°00.8',87°08.4'	8VII55	9	14	0.07
2582	121	45°04.2',87°05.9'	9VII55	10	18	0.08
2584	121	45°00.5',87°09.6'	12VII55	13	13	0.04
2548	121	45°03.7',87°04.8'	4IX55	67	18	
2549	121	45°03.6',87°07.3'	18VII55	19	16	
2580	124	44°47.2',85°37.8'	22VII55	23	111	0.20
2554	125	44°53.9',85°33.0'	1IX55	64	113	
2552	125	45°03.8',85°35.0'	12VII55	13	96	0.31
2227	133	45°47.5',86°21.5'	1VIII55	33	20	0.03
2704	133	45°37.0',86°38.7'	16X55	109	4	
2818	134	45°56.1',85°58.0'	31VII55	32	39	0.05
2687	134	45°55.0',85°55.0'	21VII55	22	39	0.07
2690	134	45°57.4',85°55.1'	1VIII55	33	42	0.05
2820	134	46°06.0',85°24.8'	5IX55	129	65	

*Calculated as 1/2 day.

Table 4 (cont.)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2666	135	45°18.6',85°18.8'	27VII55	28	48	0.07
2668	135	45°38.3',85°03.4'	9VIII55	41	65	0.07
2651	135	45°21.1',85°13.0'	24VII55	25	53	0.09
2218	137	St. Ignace	11VII55	12	92	0.32
2220	137	South Channel, Straits of Mackinac	13VII55	14	91	0.27
2216	137	45°45.4',84°57.8'	10VII55	11	77	0.29
2217	137	45°25.4',84°59.5'	13VII55	14	59	
2219	137	45°23.6',84°55.2'	6VII55	7	63	0.38
2432	139	St. Ignace	15VII55	16	55	0.14
2431	139	45°44.7',84°54.4'	12VII55	13	40	0.13
2435	139	45°45.4',84°56.0'	12VII55	13	39	0.13
2433	139	45°51.0',84°53.0'	2VIII55	34	43	
2434	139	45°45.7',84°59.0'	14VII55	15	35	0.10
2438	140	45°33.1',85°36.3'	5IX55	68	13	
2436	140	45°41.8',85°40.8'	16VIII55	48	18	
2440	140	45°45.4',85°34.0'	6X55	99	23	
2442	140	North side Bois Blanc Island	12VIII55	44	58	
2445	140	45°33.9',85°36.7'	9VIII55	41	15	
2443	140	45°45.2',85°31.0'	10VII55	11	21	0.08
2456	141	45°55.4',84°54.0'	25VII55	26	49	0.08
2464	141	46°00.9',85°01.7'	31VII55	31	45	
2460	141	45°56.5',84°56.0'	21VII55	22	48	0.09
2447	142	45°52.9',85°51.4'	8VII55	9	21	0.10
2453	142	45°52.2',84°50.1'	25VII55	26	56	0.09
3968	143	45°56.5',86°14.6'	11VII55	12	12	0.04
2854	143	45°57.4',86°10.7'	12VII55	13	11	0.04
3992	143	45°57.2',86°09.9'	10VII55	11	10	0.04
3980	143	45°57.1',86°00.8'	29VII55	30	9	
2106	143	45°57.1',86°00.8'	29VII55	30	9	
2853	143	45°57.1',86°00.8'	29VII55	30	9	
2851	143	45°57.1',86°00.8'	29VII55	30	9	

Table 4 (cont.)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2423	144	45°56.5',86°14.6'	6VII55	7	4	0.02
2422	144	45°57.5',86°12.0'	4VIII55	36	4	
2024	148	North tip of Mackinac Island	---	--	--	---
2025	148	" " " " "	---	--	--	---
2022	148	" " " " "	3VII55	4	14	0.15
2030	150	45°55.4',84°54.0'	4VII55	5	12	0.10
2026	150	45°54.6',84°55.0'**	4VII55	5	11	0.09
2031	151	Rogers City	11VII55	12	71	0.24
2033	151	45°51.0',84°53.0'	2VIII55	34	13	
2035	151	Presque Isle (east of Rogers City)	13VII55	14	88	0.26

**Still adrift when found.

Table 5. Drift Bottle Data, Cruise Synoptic I

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
3	2	29.6.54	Marine City, Mich., on St. Clair River	30.6.54	1	28.8	1.2
4	2	29.6.54	Algonac, Mich., on St. Clair River	30.6.54	1	36.0	1.5
144	2	29.6.54	Algonac, Mich., on St. Clair River	30.6.54	1	36.0	1.5
133	3	29.6.54	43°01.8',82°20.0'	2.7.54	3	12.1	0.16
135	3	29.6.54	43°02.3',82°16.0'	3.7.54	4	9.7	0.10
136	3	29.6.54	43°01.9',82°18.0'	2.7.54	3	11.0	0.15
137	3	29.6.54	43°01.9',82°18.0'	2.7.54	3	11.0	0.15
141	3	29.6.54	43°01.9',82°18.0'	2.7.54	3	11.0	0.15
142	3	29.6.54	43°01.9',82°18.0'	2.7.54	3	11.0	0.15
125	4	29.6.54	43°01.1',82°25.8'	3.7.54	4	9.4	0.10
126	4	29.6.54	43°01.1',82°25.8'	28.7.54	29	9.4	
127	4	29.6.54	43°01.1',82°25.8'	3.7.54	4	9.4	0.10
33	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
35	5	29.6.54	43°03.9',82°25.7'	3.7.54	4	1.0	0.01
36	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
37	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
40	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
41	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
42	5	29.6.54	43°01.7',82°25.9'	4.7.54	5	4.0	0.03
122	6	29.6.54	43°04.0',82°27.0'	29.6.54	0	3.0	

Table 5 (contd.)

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
94	13	29.6.54	43°55.0',81°43.9'	2.7.54	3	12.2	0.17
106	18	29.6.54	43°13.1',82°01.0'	3.7.54	4	12.4	0.13
108	20	29.6.54	43°44.6',81°43.9'	1.7.54	2	9.1	0.19
109	20	29.6.54	43°42.3',82°13.9'	30.6.54	1	6.5	0.27
110	20	29.6.54	43°42.3',82°13.9'	30.6.54	1	6.5	0.27
112	20	29.6.54	43°42.3',82°13.9'	1.7.54	2	6.5	
1199	22	29.6.54	43°59.2',83°10.5'	8.7.54	9	15.3	0.07
1200	22	29.6.54	43°54.8',82°21.6'	10.7.54	11	19.7	0.08
1196	23	29.6.54	43°55.9',82°42.5'	24.7.54	25	28.0	0.05
1220	27	29.6.54	44°02.0',83°26.3'	4.7.54	5	4.3	0.04
1221	27	29.6.54	44°02.0',83°26.3'	4.7.54	5	4.3	0.04
1222	27	29.6.54	44°02.0',83°26.3'	4.7.54	5	4.3	0.04
1247	29	29.6.54	43°58.8',83°13.6'	8.7.54	9	28.9	0.13
1251	34	29.6.54	43°55.7',82°42.3'	5.7.54	6	11.2	0.08
563	35	29.6.54	44°36.1',81°17.1'	3.7.54	4	14.3	0.15
564	35	29.6.54	44°31.8',81°21.0'	2.7.54	3	12.9	0.18
565	35	29.6.54	43°32.9',81°19.8'	3.7.54	4	13.4	0.14

Table 5 (contd.)

Bottle No.	Released: Station No.	Released: Date	Recovered: Location	Recovered: Date	Days "Adrift"	Miles Covered	Average Speed mph
567	35	29.6.54	44°34.6',81°18.4'	30.6.54	1	13.7	0.57
624	41	29.6.54	44°05.2',81°44.9'	9.7.54	10	28.2	0.12
625	41	29.6.54	44°07.4',81°41.9'	5.7.54	6	24.8	0.17
1280	43	29.6.54	45°04.3',83°23.9'	23.7.54	24	11.0	0.02
1288	49	29.6.54	44°02.8',83°01.6'	17.7.54	18	79.8	0.19
643	51	29.6.54	45°33.7',82°04.8'	9.10.54	102	2.5	
314	56	29.6.54	44°55.7',81°22.0'	4.8.54	36	35.4	0.04
620	56	28.6.54	45°04.3',81°30.9'	6.9.54	69	24.7	
621	56	28.6.54	44°52.8',81°21.4'	26.7.54	28	38.0	0.06
333	57	29.6.54	44°42.1',81°16.7'	8.8.54	40	42.3	
334	57	29.6.54	44°41.7',81°17.8'	31.7.54	32	42.0	
622	57	28.6.54	44°44.1',81°18.2'	11.8.54	43	39.1	
628	57	28.6.54	44°52.8',81°21.4'	28.7.54	30	30.4	
629	57	28.6.54	44°47.9',81°17.3'	6.7.54	8	36.5	0.20
634	58	28.6.54	45°15.6',81°40.8'	10.7.54	12	4.9	0.02
426	59	29.6.54	44°53.2',81°21.3'	29.8.54	61	40.0	0.03
638	59	28.6.54	44°29.2',80°03.9'	15.7.54	17	128.0	0.31

Table 5 (contd.)

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
642	60	28.6.54	45°18.7',81°44.8'	27.8.54	59	12.6	0.01
346	64	28.6.54	45°40.2',82°18.7'	30.7.54	32	2.0	
300	65	28.6.54	45°35.7',82°08.9'	14.10.54	117	14.0	
316	68	28 6 54	44°42.1',81°16.7'	10.7.54	12	96.4	0.33 (Rejected)
391	71	28.6.54	45°48.4',82°56.9'	13.7.54	15	8.0	0.02
1318	78	29.6.54	45°56.0',83°37.7'	11.7.54	12	6.0	0.02
1320	78	29.6.54	45°56.0',83°37.7'	11.7.54	12	6.0	0.02
1321	78	29.6.54	45°56.0',83°37.7'	11.7.54	12	6.0	0.02
1322	78	29.6.54	45°56.0',83°37.7'	11.7.54	12	6.0	0.02
1359	86	29.6.54	45°38.1',84°16.4'	25.8.54	57	7.4	
1361	86	29.6.54	45°38.1',84°16.4'	25.8.54	57	7.4	
1384	87	29.6.54	45°39.3',84°28.9'	7.7.54	8	7.0	
1385	87	29.6.54	45°39.2',84°18.8'	3.7.54	4	12.9	0.13
1387	87	29.6.54	45°39.4',84°19.4'	5.7.54	6	12.3	0.09
1353	88	29.6.54	45°39.2',84°22.8'	4.7.54	5	13.0	0.11
1354	88	29.6.54	45°39.2',84°22.6'	4.7.54	5	13.3	0.11
1355	88	29.6.54	45°39.3',84°22.3'	4.7.54	5	13.6	0.11

Table 5 (contd.)

Bottle No.	Released Station No.	Released Date	Recovered Location	Recovered Date	Days "Adrift"	Miles Covered	Average Speed mph
1368	89	29.6.54	45°39.3',84°23.0'	2.7.54	3	16.4	0.23
1369	89	29.6.54	45°38.8',84°24.7'	8.7.54	9	15.8	
1370	89	29.6.54	45°39.3',84°23.0'	2.7.54	3	16.4	0.23
1371	89	29.6.54	45°38.8',84°24.7'	8.7.54	9	15.8	
1372	89	29.6.54	45°39.3',84°23.0'	2.7.54	3	16.4	0.23
1380	90	29.6.54	45°39.7',84°25.4'	4.7.54	5	15.0	0.13
1382	90	29.6.54	45°39.7',84°25.4'	4.7.54	5	15.0	0.13
1363	91	29.6.54	45°47.3',84°26.1'	5.11.54	129	11.8	
1364	91	29.6.54	45°48.4',84°30.0'	15.8.54	47	8.0	
1365	91	29.6.54	45°46.8',84°23.2'	5.7.54	6	13.8	0.10
1343	92	29.6.54	45°49.3',84°36.3'	1.9.54	63	4.2	
1345	92	29.6.54	45°47.6',84°27.3'	11.7.54	12	11.6	0.04
1351	93	29.6.54	45°51.4',84°39.1'	12.7.54	13	3.2	0.01
1973	94	29.6.54	45°24.3',83°46.4'	15.7.54	17	48.0	0.12
1335	96	29.6.54	45°21.4',83°29.6'	10.7.54	11	53.4	0.20
1374	97	29.6.54	45°29.5',83°59.0'	4.7.54	5	26.6	0.21
1375	97	29.6.54	45°29.7',83°58.0'	7.7.54	8	24.7	
1338	98	29.6.54	45°27.2',83°52.3'	6.7.54	7	29.3	0.17
1339	98	29.6.54	45°29.6',83°57.4'	5.7.54	6	24.0	0.17

Table 6. Drift bottle data, Cruise Synoptic VI, 9 August 1955.

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2801	101	41°55.5',86°35.5'	14VIII55	5	20	0.17
2144	111	43°40.0',86°31.9'	---	--	22	---
2143	111	43°39.3',86°32.4'	20VIII55	11	20	0.08
2142	111	43°42.0',86°30.9'	19VIII55	10	25	0.10
2073	116	43°46.0',86°26.9'	12VIII55	3	2	
2075	116	43°40.3',86°32.1'	13VIII55	4	9	0.09
2066	117	43°03.3',86°14.3'	30VIII55	21	59	0.12
3918	117	43°41.7',86°30.9'	20VIII55	11	13	
2403	121	45°00.4',87°10.0'	13VIII55	4	17	0.18
2405	121	44°57.0',87°11.0'	17VIII55	8	14	
2404	121	44°57.0',87°11.0'	17VIII55	8	14	
3865	124	43°58.9',86°28.0'	19XI55	71	28	0.02
2413	125	44°12.2',86°22.1'	21VIII55	12	6	0.02
2305	126	44°33.7',86°13.6'	17VIII55	8	9	0.05
2318	130	45°24.8',86°56.2'	15VIII55	6	16	0.11
2317	130	45°24.0',86°50.8'	12VIII55	3	14	0.20
2319	130	45°24.0',86°51.0'	17VIII55	8	14	
2314	131A*	45°41.2',86°40.6'	6XI55	58	25	0.02
3859	139	45°19.3',85°15.5'	10VIII55	1	4	0.17
3846	139	45°18.9',85°16.6'	10VIII55	1	4	0.17
3831	141	45°03.7',85°43.5'	23VIII55	14	38	0.11
3795	141	45°18.8',85°16.9'	24VIII55	15	29	
3837	145	near Cheboygan, Mich.	21VIII55	12	11	
3741	145	" " "	21VIII55	12	11	
3849	145	45°44.2',84°35.1'	---	--	8	
3813	145	45°43.8',84°36.5'	13VIII55	4	7	0.07
3729	145	45°43.8',84°36.5'	12VIII55	3	7	0.10
3825	145	45°43.8',84°36.5'	---	--	7	

*At Fisherman Shoal buoy, Washington Island.

Table 6 (cont.)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
3777	148A	46°02.3',85°06.9'	10VIII55	1	2	0.08
3861	148A	46°02.3',85°06.9'	10VIII55	1	2	0.08
3860	148A	46°02.3',85°06.9'	10VIII55	1	2	0.08
3801	148A	46°02.3',85°06.9'	10VIII55	1	2	0.08
3789	148A	46°02.3',85°06.9'	10VIII55	1	2	0.08
3799	149	45°41.3',84°57.7'	18VIII55	9	20	
3776	149	45°36.4',85°05.0'	22VIII55	13	23	
3823	149	45°36.4',85°05.0'	16VIII55	7	23	0.14
3811	149	45°39.1',85°01.3'	12VIII55	3	21	0.30
3812	150	45°08.9',85°33.7'	25VIII55	16	54	0.14
3848	150	45°16.2',85°22.4'	28XI55	80	42	
3764	151	45°38.0',85°04.2'	12VIII55	3	13	0.18
3751	151	45°38.0',85°04.2'	12VIII55	3	13	0.18
3787	151	45°38.0',85°04.2'	12VIII55	3	13	0.18

Table 7. Drift bottle data, Cruise Synoptic VII, 10 August 1955.

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2196	101	41°58.8',86°33.5'	16VIII55	6	25	0.17
2199	101	41°44.1',86°53.2'	11VIII55	1	2	0.08
2197	101	41°54.0',86°36.9'	15VIII55	5	19	0.16
2198	101	41°44.2',86°52.6'	12VIII55	2	3	0.06
2683	102	41°44.2',86°52.6'	18VIII55	8	21	
2847	102	41°48.1',86°44.3'	16VIII55	6	25	0.17
2850	102	41°45.2',86°49.8'	17VIII55	7	22	0.13
2848	102	41°55.2',86°35.3'	19VIII55	9	30	0.14
2849	102	42°00.9',86°32.6'	22VIII55	12	33	
2739	104	42°00.7',87°09.6'	12VIII55	2	21	0.44
2736	104	41°59.6',87°09.0'	12VIII55	2	22	0.46
2740	104	42°02.6',87°10.0'	12VIII55	2	19	0.40
2207	105	42°07.1',87°13.8'	13VIII55	3	17	0.24
2774	111	43°58.9',86°28.1'	22VIII55	12	44	0.15
2154	112	43°43.8',86°16.1'	30VIII55	20	36	0.08
2167	114	Drummond Island	13XI55	95	300	--
2189	115	43°01.3',87°56.4'	11VIII55	1	2	0.08
3958	116	43°46.0',86°26.8'	12VIII55	2	1	
3945	116	43°45.3',86°27.3'	11VIII55	1	2	0.08
2380	121	44°43.2',87°20.1'	23VIII55	13	6	
2377	121	44°45.1',87°19.7'	15VIII55	5	3	0.03
2373	124	43°49.8',86°25.6'	21VIII55	11	39	0.15
2370	125	44°27.1',86°15.3'	19VIII55	9	9	0.04
3769	139	45°19.0',85°17.1'	5XI55	87	3	
3781	139	45°17.8',85°19.4'	13VIII55	3	4	0.06
3841	139	45°17.8',85°19.4'	13VIII55	3	4	0.06
3854	139	45°17.8',85°19.4'	13VIII55	3	4	0.06
3805	139	45°17.1',85°20.7'	12VIII55	2	5	0.10

Table 7. (cont)

Bottle No.	Release station	Recovery location	Recovery date	Days adrift	Miles traveled	Av. speed mph
2891	140	45°26.4',85°10.6'	23X55	74	19	
2892	140	45°27.4',84°59.0'	23VIII55	13	28	0.09
2786	140	45°30.1',85°14.5'	22VIII55	12	17	0.06
2880	141	45°04.2',85°35.0'	19VIII55	9	38	0.18
2876	141	45°05.2',85°35.8'	19VIII55	9	37	0.17
2871	141	45°21.1',85°12.4'	15X55	66	18	
2862	143	45°44.8',85°34.3'	23VIII55	13	26	0.08
3782	144	45°47.0',85°30.3'	25VIII55	15	35	0.10

Table 8. Drift Bottle Data, Cruise Synoptic II

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
48	1	27.7.54	Belle River on S. shore Lake St. Clair	6.8.54	10	54	0.24
50	1	27.7.54	Stoney Point on S. shore Lake St. Clair	4.8.54	8	55	0.28
293	2	27.7.54	Port Huron, Mich.	30.7.54	3	11.0	
294	2	27.7.54	Port Huron, Mich.	30.7.54	3	11.0	
296	2	27.7.54	Port Huron, Mich.	28.7.54	1	11.0	0.46
297	2	27.7.54	Port Huron, Mich.	29.7.54	2	11.0	
69	3	27.7.54	2 mi S of Courtright, Ont.	10.8.54	14	31.0	0.09
72	3	27.7.54	Port Lambton, Ont.	27.12.54	152	41.0	
101	13	27.7.54	43°50.5',81°44.0'	30.7.54	3	6.4	0.09
102	13	27.7.54	43°51.2',81°44.0'	30.7.54	3	7.0	0.10
159	18	27.7.54	43°20.4',81°44.4'	31.7.54	4	5.4	
160	18	27.7.54	43°20.0',81°44.7'	30.7.54	3	4.9	0.07
161	18	27.7.54	43°21.1',81°43.9'	5.8.54	9	5.0	
162	18	27.7.54	43°20.4',81°44.4'	8.8.54	12	5.4	
195	20	27.7.54	43°49.0',81°43.9'	30.7.54	3	14.5	0.22
197	20	27.7.54	43°49.0',81°43.9'	30.7.54	3	14.5	0.22
947	27	27.7.54	44°02.7',82°52.7'	10.8.54	14	31.9	0.09
879	D29	27.7.54	44°15.0',83°26.9'	29.7.54	2	2.0	0.04

Table 8 (contd.)

Bottle No.	Released Station No.	Released Date	Recovered Location	Recovered Date	Days "Adrift"	Miles Covered	Average Speed mph
548	58	27.7.54	Flowerpot Island	1.9.54	35	8.3	0.01
429	61	27.7.54	45°36.6',82°11.0'	25.8.54	29	7.8	0.01
431	61	27.7.54	45°36.6',82°11.0'	25.8.54	29	7.8	0.01
438	63	27.7.54	45°40.3',82°19.4'	1.8.54	5	7.4	0.06
443	64	27.7.54	45°40.3',82°18.7'	27.8.54	31	2.3	
444	64	27.7.54	45°40.1',82°19.2'	14.8.54	18	2.5	
1934	79	27.7.54	45°56.7',83°59.3'	22.10.54	87	6.0	
1936	79	27.7.54	45°58.2',83°52.9'	17.8.54	21	2.6	
1937	79	27.7.54	45°58.2',83°52.9'	17.8.54	21	2.6	
1990	79	27.7.54	45°52.9',83°52.2'	5.8.54	9	2.2	0.01
1992	79	27.7.54	45°52.9',83°52.2'	5.8.54	9	2.2	0.01
1788	87	27.7.54	45°49.0',84°34.9'	8.8.54	12	8.4	0.03
1789	87	27.7.54	45°49.0',84°34.9'	8.8.54	12	8.4	0.03
1790	87	27.7.54	45°49.0',84°34.9'	8.8.54	12	8.4	0.03
1792	87	27.7.54	45°48.2',84°34.8'	7.8.54	11	7.7	0.03
1748	88	27.7.54	45°52.6',84°38.0'	29.7.54	2	7.3	0.15
1749	88	27.7.54	45°51.4',84°38.7'	1.8.54	5	6.3	
1750	88	27.7.54	45°52.6',84°38.0'	29.7.54	2	7.3	0.15
1751	88	27.7.54	45°52.6',84°38.0'	29.7.54	2	7.3	0.15

Table 8 (contd.)

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
1813	89	27.7.54	45°42.2',84°33.8'	4.8.54	8	9.0	
1816	89	27.7.54	45°41.0',84°32.1'	3.8.54	7	11.0	0.07
1784	90	27.7.54	45°57.2',84°38.0'	1.10.54	66	10.5	
1797	91	27.7.54	45°49.3',84°38.0'	2.10.54	67	2.6	
1704	93	27.7.54	45°58.1',84°30.9'	1.8.54	5	8.0	0.07
1705	93	27.7.54	45°58.1',84°30.9'	6.8.54	10	8.0	
1739	95	27.7.54	45°57.3',84°21.2'	3.9.54	37	4.8	
1742	95	27.7.54	45°59.7',84°21.6'	10.8.54	14	7.3	0.02
1709	96	27.7.54	45°19.2',83°27.9'	22.8.54	26	56.1	0.09
1844	98	27.7.54	45°46.3',84°31.9'	3.8.54	7	10.1	0.06
1846	98	27.7.54	45°29.6',83°57.6'	1.8.54	5	23.8	0.20

Table 9. Drift Bottle Data, Cruise Synoptic III

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
1034	1	25.8.54	Sombra, Ont. on St. Clair River	1.9.54	7	25	0.15
1035	1	25.8.54	Stag Island Light-house (St. Clair River?)	29.8.54	4	13	0.13
1036	1	25.8.54	Syne Carte Point (St. Clair River)	29.8.54	4	(?30)	recovery point not identified
1037	1	25.8.54	Chenal Ecarte, W. of Wallaceburg, Ont.	28.8.54	4	36	0.50
728	3	25.8.54	at mouth Pine River in St. Clair River	29.8.54	4	18	
1145	6	25.8.54	43°09.8',82°30.8'	30.8.54	5	8.5	0.07
1049	A7	25.8.54	near Tecumseh, Ont.	5.9.54	11	65	0.24
1645	B7	25.8.54	43°31.2',82°34.8'	29.8.54	4	21.5	0.22
1646	B7	25.8.54	43°30.2',82°34.6'	30.8.54	5	23	
1642	12	25.8.54	43°07.8',82°29.7'	28.8.54	3	12.5	0.18
26	17	25.8.54	43°14.4',82°06.2'	2.9.54	8	13.5	0.07
213	18	25.8.54	43°13.2',82°00.9'	17.9.54	23	13.5	

Table 9 (contd.)

Bottle No.	Released		Recovered		Days "Adrift"	Miles Covered	Average Speed mph
	Station No.	Date	Location	Date			
1776	34	25.8.54	44°01.6',82°47.8'	28.8.54	3	4	
1777	34	25.8.54	44°01.9',82°48.2'	28.8.54	3	4	
1869	34	25.8.54	43°56.6',82°42.8'	26.8.54	1	10	0.42
1871	34	25.8.54	44°01.0',82°47.2'	30.8.54	5	5	
1872	34	25.8.54	44°01.9',82°48.2'	26.8.54	1	4	0.17
848	43	25.8.54	44°55.6',83°55.3'	31.8.54	6	6	
849	43	25.8.54	45°00.5',83°56.3'	30.8.54	5	9.5	0.07
788	48	25.8.54	45°21.2',83°33.0'	6.9.54	12	28	
818	88	25.8.54	45°41.8',84°31.5'	26.8.54	1	5	0.20
819	88	25.8.54	45°40.7',84°31.0'	26.8.54	1	5.7	0.24
820	88	25.8.54	45°40.7',84°31.0'	26.8.54	1	5.7	0.24
821	88	25.8.54	45°40.7',84°31.0'	26.8.54	1	5.7	0.24
822	88	25.8.54	45°40.7',84°31.0'	26.8.54	1	5.7	0.24
814	89	25.8.54	45°44.6',84°39.6'	1.9.54	7	3.2	
815	89	25.8.54	45°46.0',84°42.6'	2.9.54	8	1.5	
816	89	25.8.54	45°46.0',84°42.6'	17.9.54	23	1.5	
1424	91	25.8.54	45°53.7',84°49.0'	31.8.54	6	13	0.09
1013	96	25.8.54	45°53.6',84°24.9'	29.8.54	4	5.5	0.06
1581	98	25.8.54	45°33.4',84°07.8'	19.9.54	25	14.5	